THE

GEOLOGICAL

AND

NATURAL HISTORY SURVEY

OF

MINNESOTA.

13th — 14th (1884—1885)

THE THIRTEENTH ANNUAL REPORT,

FOR THE YEAR 1884.

2 vols in 1

N. H. WINCHELL, STATE GEOLOGIST.

Submitted to the President of the University, April 1, 1885.

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ADDRESS.

THE UNIVERSITY OF MINNESOTA,
MINNEAPOLIS, MINN., April 1, 1885.

To the President of the University,

DEAR SIR: I have the honor to present herewith the thirteenth annual report on the geological and natural history survey. Accompanying this is a copy of the second annual report for reprint, as that report is constantly requested by librarians and geologists who desire to complete their series, and has been out of print for several years.

Very respectfully, your obedient servant,

N. H. WINCHELL,
State geologist and curator of the general museum.

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REPORT.

I.

SUMMARY STATEMENT.

An edition of six hundred copies of the first volume of the final report of the survey was bound and distributed prior to December 1st. If the number bound and ready for distribution had been much larger the edition would have been exhausted immediately. The distribution was made in accordance with the instructions of the secretary of state, as expressed in the following circular, but the number of copies was not large enough to supply all the libraries and institutions contemplated by the instructions:

RULES OF THE SECRETARY OF STATE FOR THE DISTRIBUTION OF THE FINAL REPORT OF THE GEOLOGICAL AND NATURAL HISTORY SURVEY OF MINNESOTA.

In February, 1881, a bill was introduced in the state senate by Hon. J. B. Gilfillan, which had sundry provisions concerning the printing and distribution of the volumes of the final report of the state geologist on the geological and natural history survey of the state. Although this bill passed the senate it was lost in the house in the last days of the session, from lack of time. It is presumed that had it came to a vote in the house it would have passed, as it was approved unanimously by the senate. It has therefore been adopted and followed as far as possible, in the publication of the first volume of the survey, and

will be in the future, unless the legislature orders otherwise. Section four of this bill reads as follows:

"SEC. 4. The volumes of the final report of said survey, as they may be prepared by the state geologist from time to time, shall be issued in an edition of five thousand copies each, and shall be distributed in the name of the board of regents of the University, under the direction of the state geologist, to scientific and educational institutions, and to individuals as follows:

"To the library of each chartered college and scientific institution in Minnesota, three copies each; to each normal school, three copies; to the libraries of the institute for the deaf and mute, the insane asylums, the state prison, and every public library in the state, not otherwise designated, one copy each; to each county auditor for the use of the county, one copy; to each of the offices in the capitol, one copy; to each member of the board of regents, three copies; to the Historical Society, and to the Minnesota Academy of Sciences, ten copies each; to each newspaper published in the state, one copy; to each senator and representative of the present Legislature, one copy; to the governor and lieutenant governor, each one copy; to each assistant on the survey, who has furnished manuscript or illustrations published in the report, three copies; to other scientists in Minnesota, fifty copies; to the general office of each railroad that has furnished aid to the survey, three copies; to the library of each high school, furnishing students fitted for the freshman class of the State University, one copy; to the state library of each state in the Union, one copy; to each state university and college of agriculture and mechanic arts, one copy; to the geologists and naturalists of other states, two hundred copies; to the library of the University of Minnesota, two hundred copies; to other colleges and scientific institutions in the United States, one hundred copies; to foreign institutions and scientists, one hundred copies; and to the state geologist, twenty-five copies. The remainder shall be deposited in the State University, and shall be sold at such prices as the board of regents may determine; and the proceeds of such sales shall be used by said regents for the purchase of apparatus and books for the survey, and after its completion, for the departments of natural science at the State University."

The only departures from the foregoing, ordered by the secretary of state, consist in the delivery of two hundred copies to

the secretary of state, for distribution to the offices of foreign consuls, and the transmission of the proceeds of all sales to the state treasurer at St. Paul.

The copies remaining after this distribution will be sold at five dollars per copy for the best style, (tinted paper, half roan binding,) and three and a half dollars for the common style, bound in cloth, according to the direction of the executive committee of the board of regents, approved by the secretary of state.

All correspondence should be addressed to

N. H. WINCHELL,
State geologist,
Minneapolis, Minn.

Unless the Legislature orders otherwise it is probable that the rest of the edition, when bound, will be disposed of according to this plan.

From the last week in September to the end of the year the time and energy of the survey was given almost entirely to the work of preparing a suitable exhibit at the World's Cotton and Industrial Exposition at New Orleans. A portion of the accompanying report consists of a description of that exhibit, as prepared, with the permission of the board of regents, under the direction, and mainly at the expense of the Minnesota State Board of Collective Exhibits. From December 1st till January 11th, I was in New Orleans, occupied with the installation of this exhibit. Mr. Upham was also absent on the same work from December 1st till Christmas, and my son H. V. Winchell, who had been casually and temporarily occupied throughout the summer in laboratory and office work of the survey, and continually through the fall on the New Orleans exhibit, was left as permanent custodian of the property. The aggregate value of the articles belonging to this portion of the Minnesota exhibit is about six thousand dollars, as estimated for the placing of insurance.

Mr. C. L. Herrick who was at work on the mammals of the state, and had spent about a year in making original observations thereon, was appointed to a position on the faculty of Denison University, in the state of Ohio, and was released during the fall, and till January 1, 1885, to discharge those duties. He has now, however, resumed work, and will render his final report on this branch of the natural history of the state before the close of the year 1885.

Dr. P. L. Hatch's report on ornithology has not yet been tendered, but it is expected that it will be ready for publication in the early part of the present year.

In order to complete the publication of material already on hand, relating to the geology proper, provision ought to be made, during the legislative session of 1885, for the printing of another volume. This would be largely devoted to a belt of counties in the central portion of the state, and would be of scope and plan similar to volume one.

At the World's Industrial and Cotton Centennial Exposition, now being held at New Orleans, the State of Minnesota for the first time publicly exhibits two new products of her natural resources—salt and iron.

The brine derived from the well at Humbolt, in Kittson county, is an augury of what may be in the future. The brine which overflows at the surface has more than the average per cent of chloride of sodium found in the Michigan brines, while the total solid matter in solution (including chloride of sodium) is only from one-third to one-half as much. The probable geological formation from which this brine issues and the conditions of future successful exploration, are given in the accompanying report. I have to acknowledge the generous assistance of Mr. Valentine, owner of the well, for valuable information and for a series of the drillings from the well.

The year 1884 has witnessed a very extensive and important opening of the iron mines at Vermilion lake. Mr. George C. Stone, of St. Paul, general manager for the Minnesota Iron Company, has given every facility for the examination of the mines, and has supplied information and statistics embraced in the chapter on the Vermilion iron ores. Specimens illustrating the ores of the various mines at Vermilion lake are on exhibition at New Orleans, aggregating in weight about 2,500 pounds. Sixty-two thousand tons were shipped from the mines in the latter part of the season, delivered at Cleveland, Pittsburg and other lower lake ports. This ore ranks well, so far as assays made at the mines indicate, with the ores of the best quality from Michigan. It is believed to be derived from rocks of the same geological horizon as the ores from Marquette and Menominee.

The importance of this development to the state of Minnesota can hardly be overestimated. This is the most westerly point at which the ores of this geological horizon are known to exist. They should not be carried east for smelting and manu-

facture, but should be reduced where they are mined. Their market will for the present be in the east, but their ultimate consumption will be in the west where the settlement and rapid development of the country demand iron for all the appliances into which iron enters. The freightage of the manufactured products directly from Minnesota to supply this western demand will ultimately be seen to be so much cheaper than the carriage of the ores east and the manufactured articles again west, that the ways and means for avoiding this double freightage will be sought and found by the shrewd capitalists of the state. Such articles would compete successfully, in the western markets, with those of eastern manufacture. The coal of Iowa or Illinois would have to take the place of that of Pennsylvania, unless charcoal could be substituted.

II.

RECONNAISSANCES.

(*a*). *Notes of a reconnaissance into Pope county, May,* 1884.

This trip of observation was made at the instance and solicitation of Mr. G. Tharaldson, of Langhei.

The drift. Along the new railroad extending northwestwardly from Minneapolis to St. Cloud are various new and interesting exposures of the drift deposits, which deserve a careful inspection. They exhibit the relations of the gray and red tills, the gray overlying the red and finally prevailing entirely. There are also gravel deposits, and patches of laminated clay. Northwest of this moraine the surface is flat. At once this flat tract is seen to consist of gravel derived from the gray till, containing Cretaceous bits. At Rodgers Siding the country is timbered, and undulating, the till being gray, and very fine.

At the crossing of Crow river the gray till becomes converted into and overlain by a pebbly clay, and then by a finer loess, which last shows ten to fifteen feet in thickness at the first (outer) cuts. There is some gravel and sand considerably tinted with red, indicating the proximity of red till deposits. At a few points a red till is seen at the lower levels. After crossing the river the country is timbered and rolling for about two miles, but the surface consists of this loess, or fine silt without boulders. It then becomes flat or undulating, and the soil rather sandy, though probably a till, and occasionally is red, but mainly gray—especially gray in the upward swells and ridges that are cut by the grade.

Monticello is on a gravel plain but few feet above the river, which is apparently analogous to, if not identical with that on

which St. Cloud is situated, though at the latter point it is apparently about two miles in width.

Red granite is to be seen near the railroad bridge over the Sauk river, near St. Cloud. On crossing the river the grade ascends, apparently, to a higher flat than the St. Cloud flat, which likewise consists of gravel—at least there is no bluff on the east side, but the road runs from the plain directly on to the bridge which is about fifteen feet above the water, while on the west side it enters cuts in gravel bluffs about fifteen feet higher than the grade. With some undulations this gravelly flat continues to St. Joseph, the railroad cuts only showing gravel.

West from St. Joseph the surface becomes broken and rolling, yet consists of gravel. This gravel, however, in the distance of about a mile from Watab creek, in the direction of the railroad, gives place to a red till, even morainic till on the east side, and then also on the west side. This is the condition of the surface at Collegeville. This red till becomes yellowish, verging toward gray, interspersed with tamarack swamps. As a red till, however, it apparently continues to Avon, and to Albany, but with variations to a yellowish color. Just west of Albany a characteristic gray till appears, lying over the red, but is rather pebbly instead of stony, and the surface becomes smooth or gently undulating, and continues so to Freeport. At Melrose this gray till is covered by a loess loam, due apparently, to the former action of Sauk river in the valley of which Melrose is situated. At the crossing of Sauk river, west of Melrose, the bluff cut consists of gray till, 15 feet.

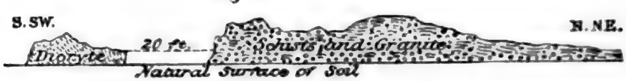
At Sauk Centre, on the diorite rock, situated about half a mile southeast from the railroad station, the glaciation runs 42° east of south (true meridian).

Crystalline rocks at Sauk Centre. This is a dark speckled rock consisting almost entirely of hornblende and feldspar, the relations of which to the red granite lying adjacent, are hid by drift. The red granite is about 20 feet distant (north) from the dioryte. The dioryte resembles that at "the point," at Little Falls, in having, over part of its upper surface, where planed by glaciation, the alternating lines of predominating feldspar with predominating hornblende, causing an appearance as of lamination, or at least a coarse gneissic structure. Except this, and some jointage planes, it is homogeneous and massive, and is exposed over an area of about a square rod. At several places, extending for forty rods further southeast, on land of Mr. Gates, this

dioryte is found in outcrop, and has been quarried. It is here a jointed, angular, firm rock, the same as at the point on Mr. Carl's land, described. It shows milky-opaque quartz, visible to the unaided eye, though no quartz can be thus discerned in it at Mr. Carl's. It disintegrates more rapidly than the granite. While it appears, in bulk, massive, it has frequent joints running in all directions, facilitating the rude methods of quarrying that have been pursued. The outward aspect of the general surface is much like that of some disintegrated portions of the Duluth gabbro range.

The adjacent red granite, which might be called gneiss, has about ten times as much area of exposed surface as the foregoing. It encloses bands and patches of mica schist. It has an abundance of evident quartz, and some of the orthoclase crystals are two and a half inches in diameter, especially when, somewhat in the manner of veins, the red granite interpenetrates and cuts across, the schists. Sometimes it runs in vanishing narrow seams coincident with the schistose direction, and sometimes it cuts boldly across it, the schists then having apparently an angular, fractured termination. This mica schist is firm, quartzose, and occasionally green as if with epidote, and would, in many places, properly be styled a gneiss. Its structure runs 60° east of north (true mer.), and is nearly vertical, but in some cases is at a small angle (two or three degrees) with a perpendicular, the dip being toward the south. At another point this structure, which stands about vertical, runs north, 88° east (true mer.). It is here disturbed by a network of veins of the red granite, and becomes exceedingly firm and dark colored, being really a dark gneiss. In the most of this mica schist hornblende is more abundant than mica, the former constituting the bulk of the dark ingredient, and the latter appearing at the planes of easy separation.

Fig. 1.



It is only in the southern part of this red granite that it has any involved dark schists or gneiss, and the nearest part is twenty feet from the foregoing dioryte. If there be a superposition, as indicated by the slope of the upper surfaces, the dioryte lies under the granite. (See figure 1.)

No. 858. Average sample of the red granite.
No. 859. Average sample of the hard, dark schist, or gneiss.
No. 860. A sample of the schist showing considerable mica.
No. 861. Average sample of the massive dioryte.

At another small area of exposed red granite about thirty rods further northwest, the enclosed area of schist strikes east and west, and dips toward the south, at an angle of about 15° from a perpendicular. Here also the general slope of the outcrop is a glaciated dome with a gentle slope toward the north-north-east, and a steep one west-southwest, rising about two and a half feet. At several places in the village, and especially on the land of Mr. Carl, the rock is found but few feet under the surface.

Mr. Carl sells stone at one dollar per cord, and lets the quarry to parties who work it. They sell for eight or ten dollars per cord.

Flouring mills at Sauk Centre. The *McClure Roller Mills* are owned by the McClure estate, and are run by water power in Sauk river. The fall is 11½ feet, aided by a dam which sets water back several miles. The mills have two Kindelberger wheels, of 48 and 35 inches diameter, producing respectively about 68 and 40 horse power. There are six sets of corrugated (Noye) rollers, and three sets of smooth rolls, with two stone buhrs for flour; the capacity of the mills being 175 barrels in 24 hours.

Artificial mounds. Near the county line between Stearns and Pope counties, along the valley of Ashley creek, are a great many artificial mounds of earth. They are on the north side of the railroad accompanying a marshy tract. The railroad passes up an old valley of glacial drainage, abundantly strewn with gravel, and these mounds are frequent along this valley. Near a school house in the valley granite outcrops are visible. This is a short distance east of Westport, and where Ashley creek receives a tributary from the south. There is another more remarkable mound situated at the point where the railroad passes between lakes Amelia and Turtle, at the western extremity of the gravel ridge on which the railroad runs between the lakes; which is so large that it can hardly be artificial. Indeed it appears more like a flat-topped remnant of an old terrace. It rises about 20 feet above the lakes, and about 15 feet above the rest of the country. It is on the north side of the railroad, and about three-fourths of a mile in diameter.

Twenty or more other artificial mounds are on the land of Dan.

F. Bartke, S. W. ¼ sec. 2, T. 125, 38, a short distance west of Glenwood. One in this vicinity is known as *White Bear mound.* This rises about 200 feet above the lake, but is situated on a natural conical hill. This is on the north side of the lake, about three miles from Glenwood. Numerous other mounds are on the low land, southwest of the White Bear mound, on the north side of Pelican lake; also north of White Bear mound, and northwesterly, scattered over the upland prairie.

Minnewaska lake. This lake, according to statements of citizens of Glenwood, was originally designated by an Indian name, meaning *Dish lake*, because of its being in a low basin. After that, when the chief, White Bear, was buried in a high hill on the north shore, it was called *White Bear lake.* After a time it was changed to *lake Whipple*, from bishop Whipple, of Faribault, and by act of the state Legislature of 1883 it was again changed to *Minnewaska*, or Good-water. It is said to be 85 feet deep in its deepest part, and averages about forty feet, and there is no known evidence of its having ever stood at a higher level.

This lake basin, which is also known, facetiously, as the "Pope county cellar," seems, to one approaching it from the east by way of the St. Paul, Minneapolis and Manitoba Railway, as he first views it from the railroad station, like some grand excavation in the rocky formation of the country. The smooth, high prairie, which, as a gravel-strewn plain, extends monotonously northeastward from the east end of the lake, breaks off rather suddenly toward the west in a remarkable depression of about 240 feet, and in this depression the expanse of the lake appears. There has been discovered, however, no rock bed in any of its bluffs, which consist, everywhere, of drift materials only.

A limestone mass, lying among the drift hills N. E. ¼ sec. 18, T. 125, 37, owned by Mrs. Sarah Peterson, in the upper part of the bluffs that enclose the lake, was suspected to be an outcrop of the native beds, and was so reputed. It was carefully examined. Its strata are nearly horizontal dipping N. W. about 2 degrees, and on excavation in front it maintains a perpendicular face as far as dug, developing a thickness of at least 5½ feet. With a probe it was found to run under the soil, southward, about 9 feet., but beyond that the probe passes too deep without striking it to allow of its being continuous *in situ.* On lower ground, in the vicinity of this limestone mass, are several large boulders of coarse, red granite, some being ten feet in diameter. About the shores of the lake are occasionally found bits of Cretaceous

lignite. It was stated that one man found a piece as large as he could carry. It *seems* to come from below the water, since it is said to appear after heavy storms.

The drift bluffs at the east end of the lake, have an average hight, as measured by aneroid, of 248 feet above the level of the lake, but some of the hills adjacent rise about 25 feet higher. These hills, and the general flat surface extending northeastwardly, are composed superficially, and largely of gravel and sand. The effect of winds and storms on this deposit has been to uncover and make superficial numerous transported boulders, especially throughout that part which has a broken contour. Thus the apparent abundance of boulders, large as it is in the original, in comparison with that of boulders in ordinary till, is superficially much increased. They are innumerable, some of them being two or three feet in diameter. In some places they literally cover the surface with a continuous pavement. These bluffs appear rough and hilly just at the lake, and between the station and the lake. From their summits the prairie level, flat or moderately undulating, is maintained eastward; but toward the northwest the surface is rough and stony, exhibiting the characters of a glacial moraine, extending to the south of lake Reno.

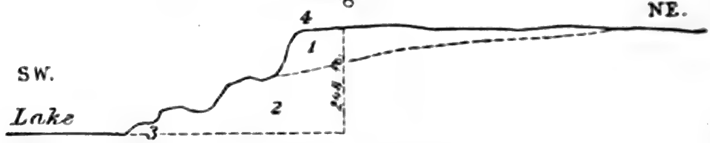
Below this covering of gray gravel, which seems to be 50 to 75 feet thick, these bluffs are composed of gray till. This is evinced by the composition of exposed cuts and slides in the frequent ravines. This underlying till sheds the water that penetrates downward in the gravel, causing numerous springs which are found at about the same horizon in the bluffs, all about the east end of the lake. The spring waters gather into little creeks, and one of these was caused to run a small flouring mill till a few years ago. The village of Glenwood is supplied with excellent water by a pipe running beneath the surface of the ground from an artificial reservoir in which several of these springs are concentrated, one hundred and forty feet above the village. The resultant pressure is sufficient to throw a stream from the hydrants in the streets, over any of the houses of the village.

The high bluffs which appear at the east end of the lake are not so conspicuous further west. They insensibly diminish, and descend finally to the "outlet," where the general level is but a few feet higher than the lake itself. In the same manner the south shore descends toward the west.

Between the tops of the hills, at the railroad station, and the

undulating or rolling surface on which Glenwood village is situated, a distance of about a mile, are curious knolls, more or less elongated, of gray, or yellow, till, rising in the midst of a general till area. The general contour of the bluff at the east end of this lake is shown by figure 2.

Fig. 2.



Explanation of Figure 2.

1. Gray gravel and sand, with many stones and boulders.
2. Yellow till, with few stones and boulders.
3. Place of Glenwood village.
4. Place of Glenwood station.

The moraine which passes along the east end of lake Minnewaska is from one-half to three-quarter mile distant from the lake, and extends N. W. from Glenwood. It is characterized, at one and two miles north of the station, by more numerous granite boulders, strewn over the tops of the knolls, among them being some of limestone. The country three miles northwest is rough, even very rough, some of the hillocks rising 100 feet higher than the station. Lake Reno is said to be forty feet higher than the railroad station at Glenwood. East from the station the surface becomes smooth, but shows a very slight eastward decline, for at least a distance of about two miles. From Glenwood the line seems to pass more southerly, into Barsness.

Springs. Allusion has already been made to the singular and persistent spring-course along these bluffs, reminding the beholder of the similar effect of the green shales of the Trenton in Fillmore and other counties in forming a line of springs near the tops of the St. Peter bluffs in those counties.* These springs afford a strongly calcareous water, and in favorable positions deposit a copious sediment of tufa. Such deposits are found on S. W. ¼ sec. 2, T. 125, 38, on the land of Daniel F. Bartke, and on that of Stillman Ayers. It is here deposited on growing moss and leaves, and lies at 100 to 150 feet above the lake. The water is shed by the underlying clayey till. In similar circumstances

*Final report, vol. 1, p. 274.

are found local beds of peat, maintained on the face of the bluff below such springs. Some of the water, on flowing again through the bog becomes sulphuretted, and similar to that of Mr. Bryan near Minnesota City, in Winona county.

Another source of springs, apparently below the clay, gives chalybeate water. This source gives origin to the springs that issue at much lower levels along some of the larger creeks that cut the bluffs in the same vicinity. They are distinct from the lime-depositing springs.

Brick are made at Glenwood by John Aiton. They are of a light red, or yellow-red color, and sell for ten dollars per thousand. Mr. Aiton also burns quicklime, from boulders gathered on the surface.

Mills. There are three mills on the Chippewa that serve the farmers of southeastern Pope county, viz.: *Swift Falls mill*, Marlue mill and West's mill. The first is a roller mill, but the others are stone mills, with three run in each.

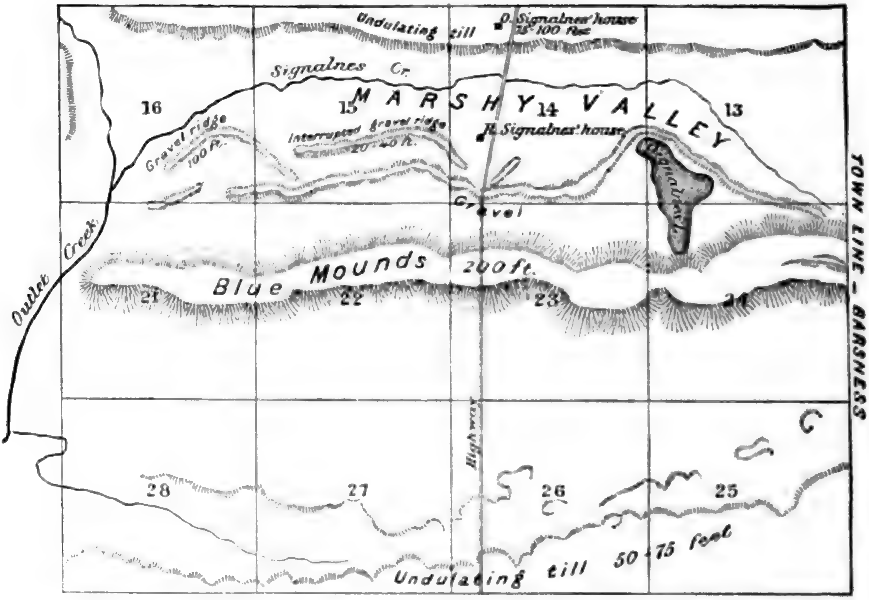
Trees. The native trees of southern Pope county are as follows: Bur oak, bass, elm, ironwood, aspen, white ash, plum, box-elder, willow, sugar maple, balm of Gilead (in Langhei), black ash, juneberry, red elm, cottonwood, black cherry, hackberry — no black oak, nor white oak.

The Blue Mounds, a remarkable ridge of drift materials running through the southern portions of Blue Mounds and Barsness townships, a portion of which is illustrated by the accompanying sketch-map (Fig. 3) has been described by Mr. Upham in the eighth annual report.* This ridge, where sketched, consists essentially of the coarser drift materials, gravel and sand predominating, overstrewn and intermingled with boulders. The pebbles are some of them from the Cupriferous, such as dark amygdaloids, melaphyr, epidote and quartz, and numerous greenstones. But the most of the larger stones are granite and hornblendic schists, with Winnipeg limestone. The bulk of the entire range seems to be gravel and sand, as evinced by the great depth of some of the depressions which only rarely contain any water and by little cuts along the roadside. It is a distinct, and almost a simple, range. Along its north side in the valley of Signalnes creek it is flanked by a subordinate parallel range rising about half as high as the main range. This range is also composed of gravel and sand. It is interrupted, sometimes

* Eight report, p. 78.

double, and presents all the characters of a glacial kame. It runs into and blends with the main range on the town line of Barsness, where it seems to contribute its contents to that range, causing the highest point in the whole series, so far as seen, in this vicinity. Toward the west the Blue Mounds are lost in crossing

Fig. 3.



the valley of Outlet creek, or the valley which Signalnes creek occupies, for Outlet creek comes through drift, and has approximate bluffs till it enters the Signalnes valley.

On each side of the Blue Mounds range is a distinct valley, that on the north side being bounded abruptly on the north by a bench or bluff of till, rising from 75 to a 100 feet. That on the south is also bounded on the south by an undulating ascent of gray till, which, within a quarter of a mile, reaches the height of 50 to 75 feet above the valley. The northern valley is occupied by Signalnes creek, but the southern valley has no distinct line of superficial drainage except at its western termination where, through section 28, a little creek is formed which works westwardly toward lake Emily. The ridge itself, where crossed by the highway in section 23, is not more that 80 rods across, and its hight is about 200 feet.

Toward the south further the till surface continues to rise, and becomes approximately flat or smoothly undulating, within a mile. In section 1, Langhei, next the Rolling Fork township line, the elevation is 1,347 feet, as determined by aneroid under favorable circumstances, the connection being made with Benson station which is 1,042 feet above mean tide.

From the high land in Langhei the "blue mounds" appear lower than the moraine at Glenwood, and with a glass the former can be seen running along eastward into Barsness as an isolated single ridge, the distant moraine being seen over it.

According to Mr. G. Thasaldson the Blue Mounds consist entirely of sand at the point where the highway from Glenwood to Benson crosses them, which is about three miles east of the point above described. The same was stated by Mr. Signalnes. Mr. Upham also describes mount Tom, in Colfax, Kandiyohi county, as composed of coarse drift materials, largely gravel and sand, this hill being in the supposed eastward extension of the "blue mounds."

As to the origin and nature of this ridge of gravel and sand, it presents all the characters of a glacial kame; but its gigantic proportions, if of that nature, would make it rank among the largest ever described in this country, since, according to Mr. Upham, it can be traced distinctly for a distance of about forty miles. Mr. Upham has, besides, regarded it rather as a terminal moraine, produced by ice moving in a northeasterly direction. While it seems necessary to give this ridge further examination, with special reference to the nature of its contents, its actual width, continuity and location, before its origin can be considered understood, there are some surrounding facts, and theoretical considerations, which indicate strongly that this range of drift hills is more of the nature of a kame, due to the action of an immense glacial river, in glacial times, than of that of a terminal moraine formed by glacier ice. The same facts and considerations would also indicate that the "Dovre moraine," in Kandiyohi county, is another great kame of gravel and sand.

The flat country at Benson, which is sandy and rather poor for wheat, extends several miles in width east and west. It is due to the former action of the Chippewa river, which now runs but little below the general level, and which formerly must have spread widely over the country, spreading sand and sandy clay. This sandy loam is twenty-two feet thick at Benson. All wells get water at the bottom of it, on the clay.

(b) Notes of a trip across the Mesabi range to Vermilion lake.

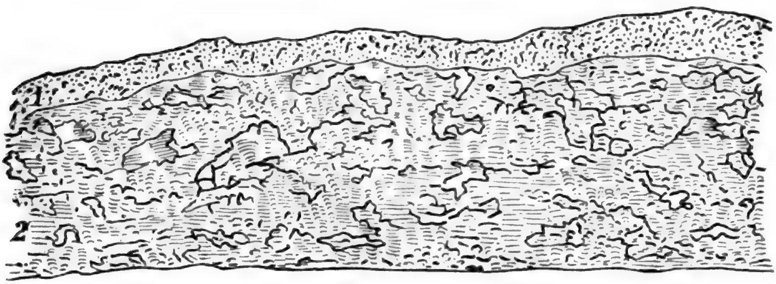
This excursion was made for the purpose of obtaining samples of the Vermilion ore, for exhibition at the World's Industrial and Cotton Centennial Exposition, at New Orleans. A few observations of geological interest were also made.

Surface features. First—There are two belts of morainic accumulations noticeable between the lake Superior shore and Vermilion lake. One is south of the crossing of the Cloquet river, about twenty miles from Two Harbors (Agate bay, of the previous reports); the second is from two to five miles north of the crossing of the St. Louis river. This is remarkable, not for the hight of the hills of which it is composed, as they are from ten to thirty feet high; but for their composition and their abrupt, and marked, and distinct outlines. These hills and ridges are short and sharp, and appear to consist very largely of boulders of gray gabbro, the till being gray and stony. On the north side of the former of these moraines, on both sides of the Cloquet river, the surface is smooth, and consists of gravel and sand, clothed with Banks' pine. These flats extend to the Wisacode, but they become swampy. After passing the Wisacode are seen occasional low ridges and knolls with white pine and birch, but cedar and tamarack elsewhere prevail, with extensive peat bogs. At the crossing of the St. Louis there is no deep valley, only a shallow one on drift and boulders, eight or ten feet deep. Timber mainly spruce and tamarack, even on the higher portions. Soil good, loamy, rather darker than the till below, but showing no black loam like that on the prairies. The soil at the moraine a few miles north of the St. Louis crossing, what there is of it, is very good, the subsoil being gray till; but largely made up of boulders. White pine abundant. After passing the sharp ridges of this second moraine the country seems to become converted to a vast "muskeg," or peat bog, with similar low boulder-knolls occasionally seen. These muskegs seem to lie on the summit of the great gabbro range from Duluth, and extend over a width of six to ten miles at least from the moraine mentioned a few miles north of the St. Louis river, to and beyond the Partridge river, which is nothing more than a general ditch in the great muskeg. North from Okwanim, and particularly at a point about eight miles south of the crossing of the Embarras, the surface is gravel-strewn, and smooth to undulating. This gravel consists almost wholly of shingle from the quartzites and slates of the

Animikie group. At the crossing of the Embarras the country is swampy, but has a good soil and is habitable and arable on both sides of the river.

Second—A common feature of the drift, seen in the cuts along the railroad, is represented by the following figure—Fig. 4. The upper portion of the drift, for a thickness of four to six feet, consists of pebbly till, but little stony (1), and the underlying till (2) is very stony, large boulders appearing all over the surface of the cuts. The upper deposit is of nearly the same color as the lower. The till in general, while of a reddish cast, has also a tendency to gray in deep cuts, and to a darker, more umber-like red in the upper deposit.

Fig. 4.



Third—There are two rock ranges, or Mesabis, passed by the railroad between Two Harbors and Vermilion lake, and the name "Mesabi" has been applied to each of them, without distinction. The more southern one is that formed by the gabbro belt running from Duluth northeastwardly to the international boundary, passing south of Gunflint and Mountain lakes, and constituting the actual water-divide between North and South lakes on the international boundary. This includes the high land of the "Mesabi iron ranges," as well as the iron locations at Mayhew lake north of Grand Marais. It is that which which has been most frequently mentioned as "the Mesabi," especially along its eastern extension where it is more distinct and abrupt, particularly from the north, than it is further west. This range of high land always appears *as a range*, from the north, and it operates more powerfully to control the drainage of the northeastern part of the state than the other Mesabi, lying further north. It is,

however, broad as well as high, and holds on its summit some of the largest lakes of this part of the state, Brule lake being one. It is characterized by bare rock, alternating with peat bogs, and muskegs with scattered and stunted spruces. This range should continue to be known as *the Mesabi.* Its width is sometimes fifteen miles, but generally from four to six; and in most places, especially north from Grand Marais, and south from Ogishke Muncie lake, its rounded low crest is distinct, and narrowed to less than a mile. The Duluth & Iron Range railroad crosses this belt of gabbro, as shown by outcrops of the rock, between the St. Louis river crossing and the station of Okwanim. It is also likely that the gabbro rock extends further south, though entirely hid by drift materials.

The other range which has been named *Mesabi* consists of gray granite, or syenite, and it is known also as the *Giant's Range.* It runs along parallel with the former, distant from it from five to fifteen miles. It is a distinct, narrow ridge rising about 200 feet above the average level on either side. It is intersected at several places by streams. It is crossed by the railroad about four miles north of Okwanim, and is less than a mile in width, though granite outcrops (red granite) may be seen at a distance of two miles still further north. This range, with more or less distinctness, continues northeastward to the international boundary which it crosses north of Gunflint lake. It is much less important as a topographic feature, and less persistent in its characters as a range, than the gabbro Mesabi and it should not be confounded with it in future use of the term Mesabi. The survey reports will refer to this as the *Giant's Range*, by which name it is also known in the reports of the Canadian survey, on the north side of the international boundary.

The stratigraphy of the crystalline rocks in the district of northeastern Minnesota, so far as it is indicated by observations of this reconnaissance, is generalized by the following diagram.

Fig. 5.

In passing upward from Two Harbors there are very few exposures, the only ones seen between the station and the crossing of the St. Louis river being within a few miles of the lake shore and consisting of the ordinary greenish "trap" of the Cupriferous. Soon after crossing the St. Louis river there are outcrops of massive, gray gabbro, the same as at Rice's point, near Duluth, and these continue to, and perhaps a little distance north of, the station called Okwanim. Thence northward the surface slopes northward and is strewn with debris of slate, undistinguishable from the slates that have been described along the international boundary, and called Animikie slates; but there is but one place along the railroad at which there is any exposure of rock. This is at the "red pan cut," about two miles north of Okwanim, where a very red and irony outcrop appears extending only about 20 feet. The opportunity for examination was not sufficient to determine the nature of this rock, but the aspect and topography, as well as the geographic position, are sufficient to indicate the horizon of the iron bearing beds of the Mesabi range proper, as described in the report for 1880, or the base of the Animikie group. The gravel which is strewn over the country along here has a considerable quantity of jasper and quartzyte, often nearly black. It continues to the granitic range already referred to as the Giant's range. This rock is massive and rises from 75 to 100 feet higher than the grade. The aneroid showed the station at the summit, as the road passes over the range, to be 155 feet higher than the station at the mines at Tower. The gray syenite composing the Giant's Range is replaced by red at a few cuts by the railroad on the north side of the range, extending for a distance of two miles, at least. For some distance further north, and until after crossing the Embarras river, no rock appears, but at a distance of about 12 miles from the station at the mines at Tower is an exposure of a purplish, aphanitic, hard rock, showing a sedimentary structure that dips toward the north about 75 degrees. The same direction of dip continues at all exposures from there to Vermilion lake, so far as observed. The rock itself is greenish, massive, magnesian, or greenish slaty, and schistose, some of it being like the rock of the ridges between the Northern Pacific Junction and Knife falls. The following diagram is not only based on these observations, but expresses in general the whole that is known of the rocky structure at any point going northward from Lake Superior.

At the mines of the Minnesota Iron Company the rock consists largely of jasper and a magnesian schist, dipping north at an angle of 85°—88°. This magnesian rock is ordinarily green, but in the vicinity of the mines it becomes more and more ferruginous and apparently is changed to iron ore—a soft red hematite. At the same time there are conglomeratic portions, as well as arenaceous. These latter are more abundant on the slope to Vermillion lake, north of the mines. The ore consists, in general, of hematite, but there are also small amounts of non-titaniferous magnetite, and small crystals of gœthite.

Stratigraphic position of the iron ores of northern Minnesota. There seem to be three horizons in the strata that, in northeastern Minnesota, have attracted attention for their iron bearing quality.

First—The titanic iron of the gabbro belt. This includes the iron ore of the Mayhew location north of Grand Marais, the so-called iron ore of Duluth and Herman, and the iron ore that has been reported on Poplar river. This furnishes the iron sand of the lake Superior beach. This horizon of iron ore seems to have no parallels, so far as reported, in Michigan and Wisconsin.

Second—The iron ore of the Mesabi range. This is hard hematite and non-titaniferous magnetite. It is that examined in towns 59.14, and 60.14, and is presumably the cause of the iron ore signs in that tract of country between Okwanim and the Giant's range. It is in the horizon of the Animikie slates, and near the bottom of the same, and the probable parallel of the Commonwealth mines in Wisconsin, without any known equivalants in Michigan.

Third—The hematite of the Vermilion mines at Vermilion lake. This is on the north side of the granite belt, and in rocks dipping north, the other two horizons being on the south side, in rocks dipping south. This iron horizon is lower, in the strata, than either of the others, and seems to be on the horizon of the Marquette and Menominee iron ores, as is also indicated by the associated quartzytes, jaspers, and conglomerates.

III.

THE VERMILION IRON ORES.

The year 1884 having witnessed the opening of the first active mining in the state, its bearing upon the future of this industry, and its importance as a matter of history, both demand of the survey a presentation of the whole matter as full and explicit as the present opportunity may afford. The following facts have been obtained mainly of the officers of the company, and can be accepted as a faithful statement of the present condition and extent of this important new industry.

In every instance where the ore was tried by actual furnace tests, it has proved its superior quality. The company are mining at the rate of 15,000 tons per month, employing at the mines 400 men, but could easily increase their product to 25,000 or 30,000 tons per month.

The buildings, machinery and plant at the mines involved an outlay of fully $300,000, and the ore docks at Two Harbors fully $200,000 more. The whole amount expended, including the building and equipment of the Duluth and Iron Range railroad (sixty-eight miles, from Two Harbors to Tower), by the Minnesota Iron Company in this enterprise is over $2,500,000.

The Vermilion lake iron district, of which the Minnesota Iron Company are proprietors, lies in the south half of township 62 north, in range 15 west, in St. Louis county, Minnesota. The greater portion of the northern half of the township is occupied by lake Vermilion.

The whole of that portion of the township which lies south of lake Vermilion belongs to the Minnesota Iron Company, excepting section 36, which is a school section. This section is in the

southeastern corner of the township, and is not known to contain any iron.

The shipping port on lake Superior for the ores of this district is Two Harbors, formerly known as Agate and Burlington bays (25 miles northeast of Duluth), which affords unusual natural advantages for the erection of ore piers and for safety and convenience of vessels of the largest class. The surveyed line of the Duluth & Iron Range railroad, between the town of Tower, at Vermilion lake, and Two Harbors, is 72 miles in length, with easy grades and curves, and offering no unusual difficulties of construction. The building of this line was done under contract by John S. Wolf & Co., Ottumwa, Ia., well known and energetic railroad builders. The line was ready for the transportation of ore by Aug. 1, 1884. This line will be at once extended to Duluth, and there placed in connection with the railroad system of the United States. The Duluth & Iron Range Railroad company have also built ore piers and made the harbor improvements at Two Harbors under the supervision of Mr. George H. White who built the ore piers at Escanaba. These piers are five feet higher than those at Escanaba and seven feet higher than those at Marquette, thus affording the best possible facilities for loading the largest vessels in the trade.

A general similarity may be observed between the Vermilion lake iron district, in township 62, range 15, and the district in the now celebrated township 47, range 27, in Marquette county, Michigan, which includes the well known Jackson, Cleveland, Lake Superior, New York, and Barnum mines, besides many others of less notoriety.

The Vermilion lake deposits, however, appear to be much larger, as far as first-class ore is concerned, than the mines in township 47, range 27, in Marquette county. The district has been examined by persons who were familiar with all the mines of Marquette county in their earliest stages, among others, Hon. Edward Breitung and Mr. Samuel P. Ely, who are among the pioneers of the Marquette district, and Mr. John N. Armstrong, the veteran Marquette and Menomonee range explorer. In their opinion the quantity of first-class ore now exposed at Vermillion lake exceeds what was exposed of that grade of ore at the same stage of development in all the mines of Marquette county. It is reasonably probable that the mines in township 62, range 15, will, in the natural order of their development, after a reasonable time, yield as much of the highest grade ore

as the mines of township 47, range 27, in Marquette county, with the Humboldt, Champion, Michigamme, and Republic ranges added.

A brief account of the results of the company's explorations thus far will substantiate this statement; although these explorations, by reason of the shortness of the time which has elapsed since the discovery of the deposits and the difficulty of getting in supplies in advance of roads or settlements, have necessarily been partial and imperfect. The most striking and natural exposures only have thus far been named and examined, which will be described in the order of their occurrence, beginning at the most eastern.

The Stuntz mine, in the northeast quarter of the southeast quarter of section 27, township 62, range 15, lies on the north side of a valley between the north and south ranges. By making a rock cutting of about 75 feet, which would be principally through the slates which adjoin the ore on the south side, a face of 75 feet could be obtained for the commencement of mining operations. The surface stripping shows a with of about 25 feet of ore for about 400 feet in length. The stripping westward was stopped by a spring hole and wet ground; there was, however, no reason to suppose that the ore terminated at that point; on the contrary there is a reasonable probability of its continuance westward. The ore is a coarse-grained red specular ore with a good lustre, much resembling the bright Republic ore of Marquette county. The belt is almost entirely pure, needing very little assorting.

The Stone mine, about an eighth of a mile west of the Stuntz, has an elevation of 25 feet above it. At the most eastern end is exposed a narrow belt of slate ore of excellent quality, which appears to be a lens lying in front, or south, of the main deposit. The main deposit is a very large one, of a close grained red specular ore of great purity, much resembling some of the best ores in the lake Superior mine in Marquette county. At the eastern end, so far as now developed, it is about 50 feet in width, gradually increasing, for 300 feet westward, to 62 feet in width and maintaining a width of 46 feet at 700 feet westward.

This body of ore, at its present stage of surface developement, in respect to the combination of size, continuous extent, and great purity, stands without a parallel in the United States up to the present time. Thus far in all the trenches, test-pits, and stripping, there has not been exposed any mixed ore whatever.

	Metallic iron.	Silica.	Phosphorus.
Analysis of surface specimens from this mine made by the Isabella Furnace Co. gave............	68.34	2.14	.053
Another by the Pittsburgh Bessemer Steele Co. gave................	68.19	2.02	.061
Another of numerous small pieces taken from every part of the surface by Mr. S. P. Ely gave.	69.30	......	.059

The Ely mine, west half of the southeast quarter of section 27. This mine includes the extension of the Stone mine westward from the point above described together with a separate deposit lying some 300 feet northwest of the Stone mine. But little surface work has been done at this deposit; although it lies at an elevation of about 20 feet above the Stone mine, the conformation of the adjoining rock occasions more or less wet ground, and it has not yet been convenient to drain the surface, which can be done, however, with little difficulty. This deposit appears to be about 100 feet in width; knobs and projections of pure ore rise above the surface at various points, indicating a large and good deposit. Its dimensions and characteristics cannot be given with the same certainty as in the case of the other mines described, because the surface has not been stripped or trenched for the reasons which have been stated. The ore is of the best quality, however, and the deposit is obviously a large one. From the first of March to the present time more ore has been discovered, both in the Tower and the Stone (in fact in every mine) than was ever known here at the time of the explorations of Chester and Wright.

The Tower mine, east half of the southwest quarter of section 27, is the most elevated deposit on either of the ore ranges. It includes, in fact, two, and perhaps three, distinct mines. The most southern of these deposits is clearly distinct from either of the others; it lies on the line of the Stone and Ely mines, protracted westward, and is probably a continuance of that deposit. The trenches show a width of about 18 feet of clean ore of the best quality. One hundred and fifty feet west of the trench which shows 18 feet of ore is a new discovery which shows clean ore for 150 feet wide. The two more northerly deposits are separated from each other by a jasper "hog's back" about 50 feet in width, and it cannot yet be determined whether they are really separate deposits, or whether they become one again in extension. There are some indications that they become one, and that the Ely mine is an extension eastward of the united deposit.

One of them shows a width of 33 feet and the other of 42 feet of clean ore of the best quality. There has not yet been time and opportunity positively to determine the length of the extension of these bodies westward; but from the lay of the ground there is no doubt of such an extension as will make as large a mine as either of the others.

The Armstrong mine, northwest quarter, section 27. This deposit lies on the northern slope of the Tower range. Two distinct deposits have been discovered here; one of the veins is 15 and the other 30 feet wide, of good ore. Their extent and relation to the other mines of the company have not yet been determined. The deposits of the district are so large and so numerous and have extended over so much territory, that there has not been time thus far to get more than a partial knowledge of them. It is quite possible that the Armstrong may prove to be an extension of the West Breitung, which is described further on.

The Breitung mine, west half southwest quarter, sec. 27, and east half southeast quarter, section 28. The main deposit at this mine furnishes a larger natural exposure of pure ore than either of the others. The natural outcropping before any work was done was about 38 feet in width, 35 in hight, and 75 feet in length, all of the purest ore. Subsequent work shows that at 250 feet east of the outcrop, the deposit is 95 feet wide. Between these points a slide of jasper has covered a portion of the vein for about 30 feet in width for a depth of from three to seven feet; otherwise than this, the ore is continuous to this point, 250 feet eastward. Here the stripping became rather heavy and was discontinued; but at a point 300 feet further eastward, on what is believed to be a continuance of the same deposit, trenches 100 feet apart showed 35 and 38 feet of the same ore with no mixture of rock.

The southern deposit of the Breitung mine lies about 125 feet south of the one just described, upon slightly lower ground. A belt of chloritic schist lies between the two.

This vein has been exposed at four different points: at the most easterly it is 27 feet wide and 100 feet in length, stripped; at the next one it shows about 10 feet in width; at the third, 15 feet, and at the most easterly, 18 feet. The distance between the extreme openings is about 1,000 feet; and there is no doubt that the vein is continuous for that distance. This ore is also of excellent quality.

About 175 feet north of west of the main deposit lies the *West Beitung.* Here has been exposed, for a length of 80 feet, a vein of ore for upwards of 50 feet in width. At that width the stripping became rather heavy and work was stopped for a time, although the limit of the ore had not been reached. This deposit has two jasper walls and is entirely distinct from the other one.

The main deposit of the Breitung mine is a bright, handsome ore, free from any admixture of rock, and can be mined (as can the ore of the Stone mine) of 67 per cent purity without assorting. An analysis made by the Isabella Furnace Company of samples from all parts of a stock pile of 2,500 tons

	Metallic iron.	Silica.	Phosphorus.
gave	68.79	1.34	.038
Another, made by the Pittsburgh Bessemer Steel Co., gave	68.19	1.41	.041
Another, of numerous small pieces taken by Mr. S. P. Ely, from all parts of the deposit, gave	68.51	......	.078

The Lee mine, north half section 33. This is a very large deposit, or rather group of deposits, upon the South range. It includes three distinct ore bodies. The most northerly is nearly or quite 100 feet in width at the point where it was first exposed. The explorations upon this deposit show its continuity, with varying widths, for about 500 feet, and the indications of the formation point to its protraction for nearly 2,000 feet farther westward.

On the highest point of the South Range, about 75 feet south of the deposit just described, a vein some ten feet wide has been uncovered, which rapidly widens as it descends.

A third ore body lies 75 feet farther south and is 36 feet wide This vein extends 700 feet to the eastward, as far as now developed, and is also probably protracted westward, as mentioned just above in respect to the first deposit. The group of deposits which constitute the Lee mine contain extremely large bodies of pure ore; and, so far as any mixed ore is found, it is not, comparatively to the pure ore, in greater quantity nor more difficult of assortment, than in the best of the Marquette county mines. An analysis of the mixed ore from this mine, selected as such by Mr. S. P. Ely, gave 61.59 metallic iron. The following are the analyses of the pure ore from this location :

	Metallic iron.	Silica.	Phosphorus.
Isabella Furnace Co	66.42	4.67	.031
Pittsburgh Bessemer Steel Co	66.37	4.72	.039
S. P. Ely's samples, from all parts of the mine...	67.80	......	.053

The Minnesota Iron Company intend to place a sufficient quantity of their ore in market at lower lake ports in the autumn of 1884 to make it known to consumers, and thereafter to produce as much as the market may require of the highest grade of ore, up to an amount equal to, or greater than, the Marquette county product of that kind of ore. As a matter of course, an unlimited amount of ore cannot be produced in a single year, and some years of development and organization of the business must pass before the full productive capacity of these mines can be reached. It will be observed that all the Vermilion lake ore is sufficiently low in phosphorus for Bessemer use, and that a practically unlimited supply of such ore can be obtained, which is also of the highest standard in metallic iron.

The existence of such ore bodies is a fact of almost national importance, and their speedy exploitation is of the greatest interest to the whole iron-producing industry west of the Alleghanies.

The policy of the Minnesota Iron Company will be to ship only the best ores. Such mixed ores or soft hematites as may be developed in the course of its mining, will be for sale at the mine for those who may require them; but the company's own product and shipments will be confined to the ores of the highest grade. Lake transportation will not be materially higher than that from Marquette to lower lake ports, by reason of the large and increasing quantity of coal which is seeking transportation to the head of lake Superior, which will give a remunerative up freight to the ore vessels.

The rapid growth and development of several of the mines in Michigan is exhibited by the following table, showing the product of the five largest mines of Marquette county, Michigan, during the last ten years.

PRODUCT OF FIVE MINES OF MARQUETTE COUNTY, MICH., FOR TEN YEARS, ENDING IN 1882,

IN GROSS TONS.

	1873	1874	1875	1876	1877	1878	1879	1880	1881	1882	Total for ten years.
Jackson mine	130,131	105,600	90,568	98,480	80,340	83,121	103,219	120,620	118,939	96,830	1,027,848
Cleveland mine	133,265	165,858	129,881	146,393	152,188	152,737	131,167	212,748	198,569	206,120	1,568,926
Lake Superior mine	158,078	114,074	129,339	111,766	127,349	109,674	173,938	204,094	262,235	296,509	1,687,056
Champion mine	72,782	47,097	56,877	66,002	70,883	73,464	94,027	112,401	145,427	159,009	897,969
Republic mine	105,453	122,639	119,726	120,095	165 839	176,221	135,231	235,387	233,786	235,109	1,649,486
	599,709	495,268	526,391	542,736	596,599	595,217	637,582	885,250	958,956	993,577	6,831,285

The probable productive duration of iron ore deposits of this character is a question in respect to which some valuable experience has been gained in working the Marquette deposits. The following table shows the aggregate production of the five Marquette county mines which have been before cited, from their first opening to the present time:

	Total production in gross tons.
Jackson mine	2,291,992
Cleveland mine	2,535,184
Lake Superior mine	2,962,965
Champion mine	1,134,912
Republic mine	1,660,508
	10,585,561

The Jackson, Cleveland, and lake Superior mines have been worked continuously since 1858, the Champion mine since 1868, and the Republic mine since 1872. Notwithstanding their large product, all of them excepting the Jackson, have as much, or more, ore in sight and as great a future product in prospect, as at any time in their history.

TABLE OF ANALYSES OF HARD HEMATITE IRON ORES

FROM THE

MINNESOTA IRON COMPANY'S MINES

IN THE VERMILION IRON DISTRICT,

VICINITY OF TOWER, ST. LOUIS COUNTY, MINN.

AUTHORITY.	Metallic Iron.	Silica.	Sulphur.	Phosphorus.
J. Blodgett Britton, Philadelphia, March, 1880, select samples	69.69	......	......	.019
Prof. Albert H. Chester, Clinton, N. Y., October, 1880, samples taken by himself from all parts of north belt	66.93	3.39	.01	.011
Samples taken by himself from all parts of south belt	66.43	3.89	none	.006
North Chicago Rolling Mill, Nov. 18, 1880, duplicates of Prof. Chester's selection, north belt	65.22	3.45	none	.064
North Chicago Rolling Mill, south belt	66.18	3.75	none	.039
Chas. E. Wright, Marquette, Mich., Sept. 1, 1881, samples taken by himself from every part of north belt	66.71	2.40	.018	.072
Do. Do. south belt	67.60	1.35	.009	.027
Isabella Furnace, Etna, Allegheny Co., Pa., Oct. 20, 1882, samples from all parts of a stock pile of 2,500 tons at the "Breitung" mine, north belt	68.79	1.34	......	.038
Isabella Furnace, samples from the "Stone" mine, north belt	68.34	2.14	......	.053
Isabella Furnace, surface samples from the "Lee" mine, south belt	66.42	4.67	......	.031
Pittsburgh Bessemer Steel Co., Nov. 10, 1882, samples from all parts of a stock pile of 2,500 tons at the "Breitung" mine	68.51	1.41	......	.041
Pittsburgh Bessemer Steel Co., surface samples from "Stone" mine	68.19	2.02	......	.061
Pittsburgh Bessemer Steel Co., surface samples from "Lee" mine	66.37	4.72	......	.039
J. Blodgett Britton, Philadelphia, Dec. 20, 1882, sample of slate ore from the "Stone" mine	69.93	.73	......	.033
Average samples taken from all parts of the "Lee" mine, by S. P. Ely, January, 1883, analyzed by Chas. E. Wright	67.80	......	......	.053

Average samples taken from all parts of the "Stone" mine, by S. P. Ely, January, 1883, analyzed by Chas. E. Wright.........	69.30	......	......	.059
Average samples taken from all parts of the "Breitung" mine, by S. P. Ely, January, 1883, analyzed by Chas. E. Wright..	68.51	......	......	.078

The foregoing are all hard hematite specular ores, and are all the analyses that have been made of the ores of the district above named since the Minnesota Iron Company commenced its exploration in 1879, excepting a single one of mixed ore from the "Lee" mine, selected as such by Mr. S. P. Ely, which has been mentioned in the foregoing pages.

Besides the land in township 62, range 15, which has been mentioned, the Minnesota Iron Company own several thousand acres in the adjoining township on the east, township 62, range 14, selected to cover any extension eastward of the Vermilion lake range, and also several thousand acres along the line of the Duluth & Iron Range railroad, and 3,000 acres at Two Harbors on lake Superior; making in all 22,488 acres.

Shipments in 1884. During the short season of 1884, after the completion of the Duluth and Iron Range railroad, and the construction of the necessary docks at Two Harbors, the products of the Vermilion mines amounted to about 1,000 tons per day, the aggregate product being 62,000 tons, distributed to various furnaces and iron works in Ohio, Pennsylvania, and Virginia.

RECENT ANALYSES OF THE VERMILION IRON ORES.

St. Paul, Minn., March 6th, 1885.

Prof. N. H. Winchell,
State geologist, Minneapolis, Minn.,

Dear sir: As I promised you, I give you below eight late analyses of our ore:

Metallic iron.	Phosphorus.	Silica.	Metallic iron.	Phosphorus.	Silica.
66.70	.042	3.71	69.27	.044	.084
68.37	.060	1.56	67.75	.051	2.07
65.65	.036	5.48	67.84	.061	1.77
66.94	.031	3.65	67.02	.051	1.75

Yours Truly,
George C. Stone, Gen'l manager.

IV.

THE CRYSTALLINE ROCKS OF MINNESOTA.

There is a series of gneisses and soft red granites, or more properly, syenites, associated with the gabbro belt in the northeastern part of the state. This red granite, or "red rock," as it has been styled in earlier reports, is believed to be due to metamorphism of sediments that had been deposited at a date but slightly prior to the outflow of the gabbro itself; and, as it has been seen to pass into subcrystalline rock and quartz porphyry, and, as similar or identical quartz-porphyry and felsite are formed when in immediate association with masses of red granite and of gabbro, interstratified with the igneous outflows of the cupriferous, this red granite has hitherto been believed to belong in the age of the cupriferous, and for the same reason the gabbro has been accepted as the basal igneous rock of the cupriferous. The cupriferous overlies the Animikie slates and quartzites; and the great igneous capping of the Animikie hills along the international boundary, from Gunflint lake to Pigeon point, is in the direct line of extension of the gabbro range. This belt of syenites and granites, with the gabbro, disappears at the west end of lake Superior, beneath the waters of the lake and of the St. Louis valley. Further southwest, and in the line of their extension, however, are outcrops of red and gray granite, on the Rum river, south of Mille Lacs, on the Mississippi river between Clearwater and Watab, and on the Minnesota river between New Ulm and the foot of Big Stone lake. The granite rocks that appear in the Mississippi valley are not lithologically similar to those of this series, while those of the Minnesota valley are more nearly identical with them. There is an outcrop of the basal igneous rocks of the Cupriferous at Taylors Falls, overlain uncomformably by some of the Cambrian (probably the Calciferous

period), indicating that the strike of these granite rocks is further south than the outcrops on the Rum and Minnesota rivers.

Still, whether these upper Mississippi granites be the analogues of the red granites north of Lake Superior, or not, those that appear at New Ulm, as they underlie a conglomerate and red quartzite, have a greater degree of probability of being on the same horizon, and exhibit also a greater lithological resemblance. In any case the gabbro is entirely lost sight of. As an outcropping, overflowing rock, the gabbro may be considered, perhaps, to have had a more intense effect as a metamorphosing agent, but one less extensive geographically, than was the effect of those forces which made possible and necessary that outflow, when acting over a broader area without actual fracturing of the crust. Thus, perhaps, the metamorphism of the strata immediately preceding the age of the gabbro outflow, may have been more profound toward the southwest further, where no gabbro is found. In apparent consonance with this, the crystalline rocks, which might be in the extension of those slates and quartzites underlying the gabbro, are found to occupy a wider belt where they cross the Minnesota valley than where they are associated with the outflow of igneous rock in northeastern Minnesota. Their prevailing schistose structure, dipping toward the southeast, if it be due to original sedimentation, is in harmony with the known strike of the red syenites northeast from Duluth. This dip seems to be changed to northwest at the foot of Big Stone lake, indicating that the Minnesota valley passes over an anticlinal in these rocks, extending from Big Stone lake to the red granite outcrop near New Ulm.

Lying toward the north of the belt of red granites of northeastern Minnesota, is a series of schists and slates, containing the iron ores of the Mesabi, and of Vermilion lake. The subdivisions of this series, so far as they can be indicated at this time, are three, viz.: (1). Slates and quartzites, with beds of dioryte (Animikie group), which, in their extension toward the southwest, would, under the foregoing hypothesis, embrace the dioryte-bearing mica schists at Little Falls, Pike Rapids, and Sauk Centre, as well as the dark carbonaceous slates of the St. Louis valley at Knife portage; and finally become the schistose granites of the Minnesota valley anticlinal. (2). Soft, greenish, slaty schists, which hold lenticular masses of light-colored pro togine gneiss, and also beds of dioryte. The horizon of the Vermilion iron mines is thought to be near the bottom of this sub-

division, or at the top of the next, but on the opposite side of a Laurentian axis, dipping north, and that of the Mesabi iron range, in the foregoing subdivision, dipping south. (3). Conglomeritic and quartzitic slates, which become fine, arenaceous quartzites, and also embrace beds of siliceous marble.

Still further north, and having a strike in the same N. E. to s. w. direction, is another range of crystalline rocks, forming a conspicuous feature both in the topography and in the geology of that part of the state. The rocks of this horizon, accepted now as the Laurentian of the Canadian geologists, consist of gneiss and syenite, mainly of a light, gray color, but also becoming red. The "Giant's range" of hills is formed by this rock. They enter the state at Saganaga lake, north of Gunflint lake, and with more or less distinctness continue southwestward crossing the Duluth and Iron Range railroad at "Messaba Heights," and the Embarras river at Squagamaw lakes. Toward the west further this range has not been traced out by the survey, but, judging from all the facts and evidences that can be gathered from other sources, this belt of Laurentian turns more westerly, passing through the north central part of the state, and swings northwesterly along the west side of the Lake of the Woods, reappearing on the east side of lake Winnipeg.

On the north side of this Laurentian axis are other crystalline rocks, occupying nearly all the remaining area of the state, outcropping along the Rainy lake river, in the Lake of the Woods, and east of Rainy lake. These seem to be alternating bands of schists and gneiss, and their extent and nature have not been ascertained.

V.

ADDITIONAL ROCK-SAMPLES NUMBERED.

The last recorded number of this series is given in the Tenth Annual Report, page 122.

No. 837. Fragments from 195 feet under Minneapolis; red quartzyte, from the deep well at the Washburn "C." mill.

No. 838. Brick-red quartzyte, from Redstone, near New Ulm.

No. 839. Fine-grained gray syenite from Sauk Rapids, Museum Register No. 4466.

No. 840. Fine-grained gray syenite, like the last from East St. Cloud, Museum Register No. 2128.

No. 841. Granite from near (north of) Motley, Museum Register No. 2596.

No. 842. Greenish syenite (1) from secs. 17 and 18, Ashley. Museum Register No. 4499.

No. 843. Dyke in the Motley syenite. Museum Register No. 2593.

No. 844. Dyke in the Motley syenite, very fine-grained. Museum Register No. 2595.

No. 845. Dyke in the granite at Sauk Rapids. Museum Register No. 2122.

No. 846. Amygdaloidal dyke rock, Maine Prairie. Museum Register No. 2123.

No. 847. Slate, fine-grained, showing sedimentary structure and slaty cleavage running in different directions, crossing each other. Museum Register No. 2681.

No. 848. Fine gray quartzyte, at least a fragmental rock though containing other minerals besides quartz, glistening with fine sparkles on a freshly fractured surface, from Little Falls. Museum Register No. 2690.

No. 849. Staurolite mica schist, Pike Rapids, near the mouth of Swan river. Museum Register No. 2689.

No. 850. Fine crypto-crystalline form of the red-rock, at Duluth, of a reddish brown color; the same as No. 42, but fresher, and less granular.

No. 851. Red granite, from Courtland, Nicollet County, opposite New Ulm.

No. 852. Conglomerate (Potsdam) Courtland, Nicollet County, opposite New Ulm.

No. 852. A. B. C. D. E. F. Pebbles from 852.

No. 853. Pyritiferous red granite, from Mannheim's silver mine, Duluth.

No. 853 A. Vein rock from Mannheim's silver mine, Duluth.

No. 853 B. Vein rock (calcite) from Mannheim's silver mine, Duluth.

No. 854. Traprock from Taylor's Falls, containing metallic copper in minute particles.

No. 855. Dark concretions from the slates at Thomson, thought by Hunt & Dawson to contain a keratose sponge.

No. 856. Vein in gabbro, at Rice's point.

No. 857. Conglomerate of shale in white sand-rock, Fond du Lac.

No. 858. Average samples of the red syenite (micaceous) at Sauk Centre, quarry of T. Carl.

No. 859. Average sample of the hard, dark schist, or gneiss, Sauk Centre, quarry of T. Carl.

No. 860. Sample of the schist showing considerable mica, Sauk Centre.

No. 861. Average sample of the massive dioryte, Sauk Centre. This is the same as described by Streng in the eleventh annual report, page 72, and by Upham on page 103.

These rocks from Sauk Centre are described on page 12.

No. 862. Pinkish, white quartzyte, Garden Valley, seven miles from Merrillan, Jackson County, Wis.; probably shows Irving's "deposited quartz." It is also probably from this that Whitfield's *Palæacmæa Irvingi* was obtained. See Vol. IV, p. 173, *Geology of Wisconsin*.

No. 863. St. Peter sandstone, from the small island in the Minnesota bottom-lands near Fort Snelling, cemented with iron and ("deposited"?) silica, so as to be hard and show different colors.

VI.

THE HUMBOLT SALT WELL IN KITTSON COUNTY.*

It has been known for many years that copious salt springs existed in the valley of the Red river of the North. From their abundance several streams have been named, as Salt river, and "Rivierè Salé." Some of these springs are in Dakota, some in Minnesota, and others, probably the most numerous and copious, are in Manitoba. Some of the earliest French explorers, notably Sieur Du Luth, mentions the fact that the Indians exhibited salt which they said had been obtained in the vicinity of certain lakes in the western prairies, said to be fifteen or twenty days travel further west.

Prof. Henry Youle Hind, in his report on the Assiniboine and Saskatchewan exploring expedition, in 1859, has summarized the principal facts respecting these springs and the salt deposits of the valley of the Red river of the North. They had been made known in Dakota and Minnesota by Prof. Keating in 1823, who accompanied Major Long to the "Sources of the St. Peter's river and lake Winnipeg." At that early date five hundred dollars had been made by a single individual from the sale of salt manufactured in one summer near Pembina. The country was so permanently and extensively saline that the characteristic *Salicornia herbacea* was found growing abundantly in its natural wild state, the only inland locality known west of the Onandaga salt springs, in New York. In 1859 the manufacture of salt from springs in Manitoba was carried on profitably for the Hudson's bay company, at Swan river and at Winnipegosis lake, the methods of manufacture being of the rudest kind.

South of the international boundary several deep wells have

* Read at the Philadelphia meeting (1884) of the American Association for the Advancement of Science.

been sunk within a few years for the purpose of getting a supply of water for stock and farming purposes. Some of these have given an artesian overflow of brine. The first of this kind in Minnesota was sunk at St. Vincent, which is on the Red river of the North at the crossing of the international boundary. This well was 165 feet deep, and only penetrated the drift deposits, the greatest thickness being taken up with a fine lacustrine clay, 112 feet in perpendicular thickness. Under this was found to be coarse gravel and sand which afforded a copious overflow of salt water. This water was not carefully analyzed, though Dr. Perley, at Fort Pembina, made tests sufficient to show it was a brine principally of chloride of sodium, but contained a considerable quantity of magnesium and calcium.

Recently another well has been sunk on the Valentine farm, at Humboldt, about six miles southeast from St. Vincent, on the line of the St. Paul, Minneapolis & Manitoba railway. This also gives a strong salt water, which rises under natural hydrostatic pressure several feet above the ground. The water is clear, and effervesces slightly on exposure to the air and the removal of the pressure.

The section penetrated by this well was the same as that at St. Vincent, but extends much deeper. The salt water was found to rise first from a bed of gravel and sand at a depth of 165 feet, but in small quantity. Between 170 feet and 180 feet, the flow of brine became very copious, rising from a coarse gravel and sand pertaining to the drift. The object of the well being to obtain water for the use of the farm, the drill was sunk deeper. It at once entered a dolomitic limestone, which was found to be 295 feet thick. This has a grain and color like that which is known as the St. Lawrence limestone in the Mississippi river bluffs. Beneath this was found a saccharoidal, siliceous sandstone of rounded grains of quartz, that still furnished a flow of salt water, which rose with still greater force. The drill then entered greenish and reddish shales, some of these being of a reddish-umber color. Fragments from the pumpings show this shale is slightly unctuous, gritless, and compactly impervious, resembling the red shale which has been penetrated in a number of deep wells in the state, and been found to have a great thickness; notably the well at Mankato in the Minnesota valley. While this shale, as shale, is impervious, it is interbedded with red sandstone, particularly in its upper portion, and from these beds of sandstone may rise an artesian flow of fresh water. At the time of my visit it had been entered but forty-six feet.

Mr. C. F. Sidener, of the university of Minnesota, analyzed this brine, and has reported the following composition of the soluble mineral ingredients:

	Grains per gal.
Silica	12.15
Aluminum oxide	2.38
Carbonate of iron	1.08
Calcium sulphate	116.08
Calcium chloride	156.55
Magnesium Sulphate	71.12
Magnesium carbonate	78.60
Magnesium chloride	91.44
Potassium chloride	42.26
Sodium chloride	2764.99
Total mineral ingredients	3336.65

Of the mineral ingredients this gives 82.8 per cent chloride of sodium, the rest being largely made up of the earthy chlorides of calcium and magnesium, and the sulphate of lime. This gives it more than the average per cent of chloride of sodium found in the Michigan brines, while the total solid matter in solution is only from one-third to one-half as much.

There is an interesting question presented by these salt springs and deep wells, of the Red river valley, viz.: From what formation does the brine issue primarily? Professor Hind inferred, from the great predominance of the salt springs over the rocks of the Devonian age, along the southwesterly side of lakes Winnipegosis and Manitoba, that the brine issues from the rocks of the Devonian. He rather discourages the expectation of carboniferous strata in the region explored by him, saying that "it appears tolerably certain that the carboniferous series is not represented in the only locality where it may be looked for with much chance of success." Sir Roderick Murchison, however, in his address before the Royal Geographical Society, on the results of the "Palliser expedition," distinctly states that it is definitely settled that in the western portion of the Saskatchewan valley the Devonian rocks are overlain by carboniferous strata. It seems reasonable to infer that these carboniferous strata extend far enough southeasterly to occupy the unobserved interval of four hundred feet of strata, stretched over a space of ten miles in breadth, "between the salt springs south of Dauphin lake, and the outcrop of the cretaceous shales on the flanks of Riding moun-

tain."* The gypseous and salt-bearing formation of Michigan might occupy this interval. That the salt water issues from near the summit of the Devonian, if from the Devonian at all, is admitted by Professor Hind. In order to issue thus along the summit of the Devonian outcrop, it must be confined in some superior basin. Professor Hind also brought home a specimen of *productus*, which had been given him by a half-breed, who had extracted it from "solid rock;" but he is disposed to discredit the authenticity of this reported "solid rock," and to refer the fossil to some boulder transported from the south by floods and ice in the Red river, although Mr. Billings, who examined it, says that "there seems to be evidence of the existence of at least a portion of the Carboniferous system in this region." The salt-bearing beds of the Carboniferous in the state of Michigan have since been brought to light, and they yield that state a very important source of wealth. Had this fact been known by Professor Hind, it seems to me he would not so summarily have dismissed the idea of Carboniferous salt-bearing strata, and all other Carboniferous strata so plainly indicated by the single specimen of *productus*.

The horizon from which the brine issues at Humboldt appears to be in the Cambrian. It seems to pervade several geological horizons, from the summit of the Devonian downward to the Potsdam — but only superficially, the original source being higher than the Devonian. It is confined by the overlying sheet of impervious clay of which the drift mainly consists in the Red River Valley, and is held under hydrostatic pressure by the downward pressing fresh waters that enter the same pervious-gravel-and-sand stratum at higher levels toward the east, south and west. Where the salt springs occur it finds escape to the surface through openings in the clay-sheet. These springs seem to be most frequent and copious in Manitoba, along a belt of country running east and west, where, for some reason, the drift-sheet is much less thick than it is further south. That brine so pure and so strong should be found at so great a distance, both stratigraphically and geographically from its source, indicates the purity and strength of the brine in its native strata.

It remains for the future to determine whether these salt deposits shall become economically of importance to the Northwest. It is certainly the dictate of wisdom to give them a thor-

*Reports of Progress, together with a preliminary and general report on the Assiniboine and Saskatchewan Exploring Expedition. Original edition, quarto, p. 175. Henry Youle Hind.

ough examination and a fair trial. If these brines originate in Carboniferous strata that strike through the base of Riding Mountain, they can easily be discovered in their native place. If those strata exist in that locality the strongest brine would naturally be found by sinking wells into them at some point further toward the south and southwest.

A sample of salt made from this well was exhibited at the New Orleans Industrial and Cotton Centennial Exposition, this being the first ever made from brine native to the state of Minnesota. It was furnished by Mr. Valentine.

Section of the Humbolt Salt Well.

This well is on the line of the St. Paul, Minneapolis & Manitoba railroad, near St. Vincent, in Kittson county, S. ½ of sec. 23, T. 163, 50, five miles east of the Red river of the North, and four and a half miles south of the international boundary. It is seven feet above the highest known flood stage of the river, *i. e.* for ten years.

1. Soil (8 - 12 inches black)	4 feet.
2. Lacustrine clay, with lime concretions, appertaining to lake Agassiz. In this is found good surface water, and many wells stop in it. It is somewhat pervious to water, so much so that it sometimes allows free entrance of good water. It is very fine and can hardly be called sand, though it is probably the same as called sand at the Lockhart farm	4 - 16 feet.
3. The same deposit as the last, but more impervious, hence more moist, darker colored, gritless, and thought to be (wrongly) the cause of foul water. This is very slippery, rather darker than can be called "blue clay," yet is apparently a downward continuation of the last	16 - 140 feet.
4. Pebbly blue till; salt water at 165 feet in small quantity	140 - 160 feet.
5. Drift gravel and sand, supplying an abundant discharge of salt water, flowing over the surface. This is mainly a gray sand, but contains drift pebbles as large as an inch, mainly of limestone	170 - 180 feet.
6. Dolomitic limestone, of a grain and texture like the lower magnesian of southeastern Minnesota, in fragments obtained by driving a pipe into the drilled hole; of a buff color	180 - 190 feet.
7. Powder, of the color of the last; effervesces in NO_5; supposed to be the drillings obtained from the same rock at greater depth; very fine and unidentifiable by the naked eye	190 - 300 feet.

8. Powder, effervescing rapidly, containing some fine fragments of a compact fine-grained limerock of a slightly reddish cast.. 300–400 feet.

9. Fine drillings of a reddish limerock of shale, with some grains of white quartz. When washed the grains are seen to be mainly of limestone.. 400–475 feet.

10. Reddish sand, of rounded quartz grains. The flow of salt water increased.. 475–500 feet.

11. White sand, of rounded quartz grains. Flow of water still further increased.. 500–532 feet.

12. Faintly reddish quartz sand, in rounded grains............ 532–546 feet.

13. "Soapstone" shale, slippery, red and green, apparently in some alternation, the only representatives of this being in masses of powdered rock and fragments that adhered to the sides of the drill. When washed the grains consist of reddish and gray, or grayish-green shale with considerable white sand....... 546–550 feet.

14. The same in condition of wet paste, having a dark gray color.. 550–556 feet.

15. The same, reddish-brown, or umber-brown.................. 556–560 feet.

16. The same, brown, but containing grains of a white mineral which in the air turns to a white powder. It effervesces in nitric acid.. 560–571 feet.

17. The same, but having a more liberal intermixture of a green color, so as to be in general considerably lighter. When washed this shows many bits of dark green shale, and also some of brown, as well as white sand... 571–592 feet.

18. Greenish-gray shale, the same as No. 13....................... 592–610 feet.

19. Greenish shale, containing bits of grayish quartzyte that feebly effervesce in hydrochloric acid. This is unwashed........ 610–635 feet.

20. The same unwashed.. 635–638 feet.

21. Washed grains consisting mainly of rounded quartz (from above), angular, opaque, gray quartz, freshly fractured, and numerous scales and masses of mica. It appears as if the rock here struck is a greenish-gray, foliated, micaceous quartz-schist.. 638–639 feet.

22. Washed drillings, consisting mainly of bits of angular quartz (some, however, are rounded, probably from above), black mica scales, and angular grains of flesh-colored orthoclase, and a white feldspar, evidently one of the Laurentian granites as seen at the Lake of the Woods.. 639–641 feet.

23. The same, but cut much finer, and showing rarely a greenish scale as if of talc.. 641–644 feet.

The boring ceased at 644 feet.

Other deep wells in the valley of the Red river of the North.

Further information respecting artesian and other deep wells in the northwestern part of the state, and particularly in the valley of the Red river of the North, is contained in the sixth

annual report, in the eighth annual report (page 113), in the ninth annual report (page 166), in the eleventh annual report (page 146), and in the following letter from Mr. Springer Harbaugh:

ST. PAUL, MINN., March 20, 1885.

Prof. N. H. Winchell, State Geologist of Minnesota:

DEAR SIR: You have asked me to give my experience regarding artesian wells in the Red River valley, as well as other matters that have come under my observation in this comparatively new and undeveloped country. I will gladly comply with your request, and if I can impart any information that will be of interest to your constituency, or the country generally, I will be indeed gratified in so doing. We commenced our first farming operations on the Keystone farms, located in Polk county, Minn., and on the Lockhart farms, located in Norman county, Minn., in the spring of 1880. The first matter that demanded our attention was to find water for the large amount of stock required in our operations. We sunk and curbed at both places several wells to the depth of from forty to sixty feet, and found an inexhaustible supply of water in all of them. In some of the wells the water came up to within a few feet of the top, and at first it was sweet and good, but after a few days' standing it became so obnoxious that it was not fit for man or beast to drink. We then conceived the idea of drilling down a greater distance and casing with six-inch pipe. Our first effort was made at the Lockhart farms, in 1880. After reaching a depth of about one hundred and sixty feet we struck an extraordinarily heavy flow of water, apparently sufficient to propel a mill with one set of burrs. At a distance it had the appearance of a monument thirty or forty feet high. During the winter of 1880–81 the pipe of this well became filled up with gravel and sand and stopped flowing. We endeavored to clean it out in the spring of 1881, but the well driller lost his drill in the pipe and it became so imbedded in the sand and gravel near the bottom that he was unable to extract it with his inadequate appliances, and we drilled another well a short distance from the first and struck water at about the same distance down, of large flow, but not so heavy as our first well, and which still keeps up a regular and undiminished supply, which we have carried into our buildings

through pipes, and thus we have a great abundance of water of the purest character for all domestic purposes. Fearing that we might again have trouble and possibly the pipe again become obstructed, we subsequently drilled another well at our Lockhart farm headquarters about seven hundred feet distant from our first well, and struck water at about the depth of one hundred and thirty-seven feet, and the flow and pressure was alarmingly heavy. Within twenty-four hours the water found vent alongside the pipe, making a large hole and fairly boiling up in such large and alarming quantities that we soon became inundated, and we at once concentrated a large force of ditchers from St. Paul and the neighboring towns, and constructed ditches several miles to the west, to carry off the surplus water. After, say a couple of weeks, this heavy flow somewhat ceased, and has since been principally confined to the pipe with only a moderate and controllable quantity coming to the surface outside the pipe. This flow through the pipe is still heavy and strong, and could be carried through hose to the highest points of most any building. We sunk other wells on this farm, and cased with three-inch pipe, and have quite heavy flows of pure, semi-soft water. At the Keystone farms, in town 152, range 48, during and since 1881 we have drilled eight artesian wells, and they all have regular, continuous flows of pure, good, semi-soft water. With our first wells we used six-inch pipe, then three-inch pipe, and subsequently two-inch, which we regard sufficiently heavy for farm use. We struck water on this farm at from ninety-five to one hundred and twenty feet, with one exception, where we reached water at one hundred and fifty feet. At one point of this farm where the land is elevated about five feet above the surrounding country, we drilled several test wells and found brackish artesian water at the depth of ninety feet, which we abandoned. We then determined to drill considerably deeper, and struck a pretty heavy artesian flow of milky, brackish tasting water, at the depth of two hundred and fifty feet, which we immediately abandoned, and then selected a point on lower ground, 1,200 feet distant, and found good artesian water at about the depth of one hundred feet. We have now eleven good and satisfactory artesian wells on both farms. In drilling these wells we penetrated through strata of earth about as follows: First through the usual black loam from one and a half to three feet in depth; then through a lightish clay marl from five to seven feet in depth; then through a blue clay varying from thirty to sixty feet in

depth; then a stratum of hard pan; then sand, and finally gravel, when water is generally struck. Between these strata we generally passed through intermediate seams of quicksand and also seams of gravel. I will at this point state that the light clay marl, as well as the blue clay, appears to be fully impregnated and mixed with all the chemical and fertilizing elements requisite to produce the peculiar kind and quality of grain that is becoming so valuable and necessary for human food. I claim that our subsoils are strong and valuable fertilizers. The blue clay when first brought up is pliable, greasy, and of a puttyish nature, and when exposed to the air and dried it makes a valuable dressing for the land. It is, therefore, fair to suppose that we have our fertilizing elements immediately under us for all time to come, and which gives inestimable value to the lands of the Red River Valley and our Northwestern country. I am advised that the farmers of Clay, Norman, and Polk counties are sinking a great many wells, and have generally been successful in obtaining good artesian flows of pure water.

Before closing this communication I beg leave to call your attention to the matter of natural gas, which, as you are aware, is attracting the attention of the people of Western Pennsylvania, West Virginia, and Northeastern Ohio, and working such a marvelous revolution in utilizing it for fuel and heating purposes in those sections of our country, and to such an extent that it is largely taking the place of coal in the various large manufacturing establishments and in private families, at a comparatively small cost as compared with even the present cheap fuel of those sections. This natural gas is obtained in drilling to the depth of from 1,500 to 2,000 feet, and is frequently conveyed in pipes very many miles; the pressure varies, but it is extremely heavy. I merely advert to this matter to give you scientists and thinkers a little food for reflection. Is there any probability of our finding natural gas and reaching it at any practicable working depth in this northwestern country? I am impressed with the belief that our good Creator has something in reserve for us, and that this great and good country will not have to be dependent for ages upon distant localities for this all important element to the comfort of mankind. Whilst it may be scientifically thought that Minnesota is located outside the belt where natural gas can be reached, I am still deeply impressed with the belief that efforts should be made whereby the question can be practically tested, and at least use the means to the end hoped for. Very respectfully,

SPRINGER HARBAUGH.

VII.

THE DEEP WELL AT LAKEWOOD CEMETERY, MINNEAPOLIS.

This well is situated on the south side of the cemetery, near the beginning of the tamarack swamp, which connects lakes Calhoun and Harriet, but on high ground, about 50 feet above the lake. It is 75 feet above the Milwaukee depot, or about 900 feet above the sea.

The following general statement of the drift was obtained from the Superintendent (F. M. Gray) and from observations on the drillings as they were shown during the progress of the work. Samples of these, and of the rock strata, to the bottom of the well have been preserved and are deposited in the General Museum for future reference and verification:

1. Gravel and sand; mainly referable to the blue till as its source. It is suitable for road-making; the upper portion of this, not noticed by Mr. Gray, consists of yellow loam, such as covers the most of the country, making the soil, having a thickness of 1-4 feet........ 135 feet.

2. Yellowish, ochery, or rusted clay in which the stones, and all boulders, one of which was broken and brought up in fragments, have a ferruginous coating or weathering........ 135–138 feet

[This seems to have been the bottom of the old preglacial (rather interglacial) river gorge. It is evinced by this weathered material. A boulder of syenitic gneiss as large as a man's fist, which was said to have been brought up in the pump, was exhibited by the men at work. It was weathered and looked so much like a surface pebble, such as can be found anywhere now on the top of the ground, that at first this statement was disbelieved. But when the Superintendent showed a piece of hard gray granite, evidently freshly fractured by the drill, having a red weathered exterior, I was inclined to believe that the pebble of gneiss also may have come from this depth.]

3. Blue till........ 138–212 feet.

4. Gravel and sand and blue till. This was changeable, and seemed to be as if interstratified, but of course that could not be stated on the basis simply of the pumpings........................... 212–248 feet.

5. Boulders of Trenton limestone, and of granite, with some sand all more or less involved with some blue till. The rock was struck next below this, and at a depth of 264 feet beneath the surface. This depth seems to demonstrate the existence of some great excavation in the strata, probably, as supposed in the report on Hennepin County,* the old gorge of the Mississippi river, at least in interglacial times.................................... 248–256 feet.

6. Quartzose sandstone, in friable strata or massive, composed of rounded grains of pure quartz................................ 256–276 feet.

7. The same .... 276–296 feet.

8. The same.. 296–318 feet.

9. At the depth of 318 feet about one-half of the washed drillings are found to consist of dolomitic rock, and the rest of the same white sand. Some of the coarser fragments show that this dolomite is compact, fine grained, of a yellowish-gray color, approaching, in both respects, some of the strata of the Cambrian. Occasional fragments of crystalline rock, found in the drillings here, and before, evidently are derived from the drift below the point at which the pipe stands on the boulders, etc., of No. 5 ... . 318 – 320 feet.

10. At 325 feet the pumpings consist almost entirely again of white sand. Hence the dolomitic layers seem to have been not greater than ten feet in thickness .... 320 – 325 feet.

[At this point some pebble or other obstruction in the drill-hole caught the drill and caused the breaking of one of the wooden poles, and a delay, the drill being lodged and wedged fast. When the drill was got started again and the pumpings were preserved, the samples exhibited (Aug. 15) were said to have come from the depth of 360 – 403 feet, and nothing was said of the interval between the last preserved record (325 feet) and 360 feet. Hence there is no certainty whether it contained drillings like those at 325 feet or at 360 feet.]

11. Slightly red, fine grained, dolomitic rock, of homogeneous characters.. 360 – 403 feet.

12. About one-half of the drillings are like the last, and the rest are of rounded, white, translucent, quartz-grains like the next. It is probable that the mixture is occasioned by the infrequency of the pumping, and not by an original mixture in the rock. The transition from dolomite to sandrock took place in this interval.. 403 – 416 feet.

13. Translucent, rounded grains of quartz, almost nothing else .... 416 – 424 feet.

14. The same as the last. At the time of this visit the workmen exhibited some fragments consisting of white chert coated

* Fifth Annual Report, page 177.

with fine rhombohedrons of dolomite of the same reddish color as the rock at No. 11, with a few scattered cubes of pyrite, but they could not assign any definite horizon to them, saying they picked them out of the pumpings. They are probably from the reddish dolomite, but may be from the top of the sandrock when the passage from one to the other is apt to alternate from sandrock to dolomite in thin beds accompanied by chert................ 424 - 434 feet.

14. White quartz sand, rounded.. 434 - 481 feet.

15. White quartz sand, with traces of light green shale, and occasional small, aggregated, clustered, cubes of pyrite, the clusters being about the size of mustard seeds .... 481 - 504 feet.

16. White quartz sand, rounded, with some green shale. In mass this does not appear so clearly white as the last two, but a dirty white, apparently due to some soft, colored material ground up by the drill, which, on getting dry cements the sand grains into fragile lumps.. 504 - 558 feet.

17. White sand and green sand, the latter mainly ground to a fine powder, so as to stain the whole and make a greenish, fragile, loose mass, when dry. Some of the green sand is like the distinct green sand lumps seen in the St. Croix, at Red Wing.. .... 558 - 607 feet.

[The interval unrepresented by drillings, from 607 feet to 694 feet, probably was made up of the same as the last, or, perhaps, more like the next.]

18. White sand... 694 - 763 feet.

19. Mainly white sand, but having a mixture of other grains that are not silica, and of a heavy cementing substance that, when dry, seems to be a powdered rock of some sort, of a light buff and pinkish color. The mass, however, does not effervesce. Some scattered grains are green and soft, and may be the source of the coloring cement... 763 - 780 feet.

20. Green clay or shale; non-effervescing, very fine grained.. 780 - 935 feet.

21. White sand, with a faint yellowish tint...................... 935 - 1005 feet.

22. Siliceous sand, with a faint pinkish tint, rather fine......1005 - 1010 feet.

23. Siliceous sand, with a deeper pinkish tint, rather coarse grain, some of the grains being amethystine, and others of a light yellow color.. .1010 - 1060 feet.

24. Siliceous sand like the last, but of a lighter color ....1060 - 1105 feet.

25. The same, but cemented, when dry, with ground-up, reddish shale, probably derived from some beds introductory to the next...1105 - 1123 feet.

26. Compact, red clay, or shale, like that seen at Fond du Lac, below the red sand rock, and interstratified with it.... ....1123 - 1167 feet.

[At some places between 1123 and 1167 feet, several pieces of red shale, mottled with light green, were brought up by the pump. Some of these are two inches across. They are fine-grained, gritless, and sparkle with fine flakes of talc or mica. The green portions of this shale are finer grained than the red, and also are harder. The red has a powder that is reddish-umber in

color, and the green parts have a powder nearly white, or at least greenish-white. Within the green can be seen, under the loop, scattered, distinct grains, of much darker green, nearly black, which are about as hard as talc, and mash easily under pressure, with a greenish powder. The greenish shale seems to be subcrystalline. It occupies patches that are broad but thin, and constitutes but a small part of the whole; but it is intimately blended with the red in structure. According to Mr. Gray, this reddish-brown shale gradually became harder, and at 1235 feet it was a hard rock, and continued so to at least the depth of 1286 feet, where the drill was at work when this information was obtained.

At 1235 feet a somewhat harder stratum was reached. The drillings have a reddish color, but show angular fragments of gray or greenish slaty rock, soft, gritless, glittering with fine flecks and resembling Nos. 450 and 452 of the geological survey series (blue), but less hard. These fragments evidently show the nature of the rock at this depth, the red color of the drillings being caused by intermingling with material from the overlying beds, the well at this depth not being piped. Some of the fragments of gray or light green shale are an inch across. The sand grains, and all the reddish coloration, are undoubtedly from the higher strata. The gray-green shale is fragmental, not crystalline, except as it may contain grains from the crystalline rocks, glitters with light-colored scales of mica, macerated by water and friction, and also holds rounded grains of a green substance, which outwardly is nearly black but within is much lighter, and which mashes easily, evidently the same substance as mentioned already.]

27. Reddish-brown schist, hardness about four and one-half or five, with a gray streak or powder, glistening with reflecting, minute points of some mineral which it is impossible to name, but which may be mica scales. This has the general outward aspect of an impure hematite, but its powder and its weight show it is not an iron ore of any kind. On washing a considerable quantity of the drillings from this interval (really labeled from 1260-1380 feet), the residue consists of grains of a great variety of rocks, demonstrating that great care must be taken in drawing inferences from the appearances of the drillings furnished by the usual well driller, and that the drillings from the upper portions of the well are constantly mixed with those derived from below, in such abundance often as to screen entirely the true character of the lowest strata from the notice of the geologist. The grains in this instance consist of the following kinds: (1) Conspicuously, white, limpid sand. (2) Brown schist, with a gray or light streak, making the greater part. (3) Soft greenish slate. (4) Red, soft shale with spots of green. (5) A few bits of an arkose-like sandstone, with a pea-green interior color. (6) A gray, hard, fine-grained schist, not foliated like (2), but having an angular

fracture, as if massive, and (7), A single, large piece, of a dark, medium-grained, massive rock, like a dioryte. These last, (6 and 7), evidently are from near the bottom of the drill, as they are the last to appear among the drillings................1167 - 1400 feet.

SUMMARY OF THE WELL DRILLED AT THE LAKEWOOD CEMETERY.

1. Drift, 1 - 256 feet.. 256 feet.
2. White sandrock, 256 - 318 feet...................... 62 feet.
3. Dolomitic rock, 318 - 403 feet........................ 85 feet.
4. White quartz sandrock, 403 - 504 feet.......... 101 feet.
5. White quartz sand and green sand, 504 - 780 ft. 276 feet.
6. Green clay or shale, 780 - 935 feet................ 145 feet.
7. Siliceous sand, yellowish or pinkish, 935 - 1105 feet.. 170 feet.
8. Soft red shale and sandstone, with greenish mottlings, has red powder, 1105 - 1167 feet... 62 feet.
9. Harder, reddish-brown rock, not arenaceous, a schist, has light gray powder, 1167 - 1400 feet.. 233 feet.

The boring ceased at 1400 feet.

The drilling of this well was subsequently continued to the depth of —— feet. At 1860 feet the washed drillings consisted largely of white, limpid, rounded quartz grains, from above, and of a gray, tough crypto-crystalline rock, which showed the nature of the rock at that depth, resembling many of the strata seen in the rocks at Thomson and thence to Knife Falls, of which the survey numbers four hundred and sixty-nine and four hundred and seventy-three might be mentioned. Some larger fragments were black and graphitic, and throughout the whole were numerous battered films of metallic iron from the drill.

VIII.

NOTES ON THE ARTESIAN WELLS AT MENDOTA, HASTINGS, RED WING, LAKE CITY AND BROWNSVILLE, AND ON THE DEEP WELLS AT ST. PAUL.

The well at Mendota was drilled by W. E. Swan, and the following designations are his. The point at which the well begins is sixty-five feet above the Mississippi river, within the river gorge, and so near the rock bluff composed of the Trenton limestone and the St. Peter sandstone that the drill encountered some of the old, fallen masses of the limestone at some depths below the top of the St. Peter, which is visible in the immediate bluff about fifty feet distant. The St. Peter sandstone rises forty-seven feet above the top of this well. The top of the well is about seven hundred and fifty feet above the sea.

No. 1.	Limestone. [Fallen masses of the Trenton — N. H. W.]	22 feet.
No. 2.	Brown sandrock	60 feet.
No. 3.	Blue shale	30 feet.

[This, which here is designated blue shale, is probably not all blue shale. It holds the place of the Shakopee limestone, and is about on the horizon where the known upper strata of that formation, about a mile east of Hamilton, with the theoretical dip that must be assumed toward the northeast, would require the Shakopee. The Shakopee everywhere in Scott and Dakota counties causes remarkable bogs, indicating the impervious, shaly nature of the formation. Moreover, it becomes arenaceous, as well as shaly, as may be seen at Northfield. Its firmness, under erosion, is reduced by these qualities, and it also is less frequently seen — N. H. W.]*

*According to Rev. James Dobbin, the following alternations of strata were found in sinking a well at the Shattuck School, Faribault, indicating that the top of the Shakopee there was found to be a blue elay 5 feet thick: Clay soil, 9 feet; limerock, 21 feet; sandrock, 117 feet; stiff, blue clay, 5 feet; fine, brown sand, 3 feet; striking a very hard stone, which was regarded granite, but which was probably the firmer dolomitic beds of the Shakopee, which can be seen in the valley ofthe Cannon river, a few miles further north, and near the Cannon Valley roller mill.

No. 4.	Sandrock	35 feet.
" 5.	Magnesian limestone	145 "
" 6.	Sandrock	95 "
" 7.	Gray shale	50 "
" 8.	Green shale	110 "
" 9.	Limestone	10 "
" 10.	Blue shale	30 "
" 11.	Sandrock	50 "
" 12.	Gray shale	40 "
" 13.	Green shale	35 "
" 14.	Very hard red sand rock, enclosing beds of red shale	145 "
	Total	857 feet.

"No. 5 of this well seems to be the same limestone that outcrops at Hastings. We struck a crevice when we got 40 feet into this stratum, from which the water began to flow at the rate of 40 gallons per minute. A second flow of water was obtained from No. 11 (sandrock). When we got through that sandrock, the well flowed 300 gallons per minute. After we got through drilling we tubed the well and separated the upper vein of water from the lower vein, and we found the lower water to be much softer than that which comes from the upper vein. We also found that the water from the lower vein rose 14 feet above the surface, while that from the upper vein would only rise 4 feet. No water was obtained from the red sandrock (No. 14); there was no increase in the flow after passing through No. 11."

The Hastings deep well was drilled by W. E. Swan, and the information here given respecting the character of the strata is derived from his notes and from a series of the preserved drillings which he has furnished. This well is located at the depot of the Chicago, Milwaukee and St. Paul railway, about seven hundred and ten feet above the sea, and about ninety feet below the top of the St. Lawrence limestone as exhibited in the bluffs adjoining. The water rises fourteen feet above the surface.

1.	Dolomitic limerock. *St. Lawrence*	80 feet.
2.	Sandrock	15 "
3.	Dolomitic grit, (Mr. Swan designated this limestone)	12 "
4.	Sandrock, supplying no water	95 "
	[Some of this is coarse and some is fine. In the lowest ten feet the drillings contained fragments and rusty tubes that recall the tubes in the St. Peter sandstone described in Vol. 1. p. 656, but these are much firmer.]	
5.	Sandy shale, white, mostly sand	25 "
6.	Gray shale, with much sand and some dolomite	43 "
7.	Green shale, *i. e.* sand and green sand	20 "
8.	Green shale, probably pulverized green sand	110 "

9.	Sandy shale, sand and green sand	15 feet.
	[Nos. 6, 7, 8 and 9 may all be described as sand and green sand.]	
10.	Sandrock with a few lumps of iron pyrite	20 "
11.	Sandrock with a few lumps of iron pyrite	20 "
12.	Sandrock with more iron pyrite ; first flow of water	20 "
13.	Gray, sandy shale	20 "
14.	Blue shale	70 "
15.	Sand and pulverized green sand	20 "
16.	Dolomitic grit with gray shale and sand	5 "
17.	Sand rock with lumps of iron pyrite and dolomitic grit Second flow of water	5 "
18.	Sandrock with some pyrite	25 "
19.	Sandrock, coarse	10 "
20.	Sandrock	10 "
21.	Sandrock, coarse	10 "
22.	Sandrock	100 "
23.	Sandrock, coarse	30 "
24.	Sandrock, fine and coarse, some grains one-quarter inch in diameter, one of black quartzite, with traces of red shale	40 "
25.	White quartz sand, mixed with pinkish, apparently orthoclose sand, and some grains of red and black quartzite	30 "
26.	Red shale, with some white quartz sand	20 "
27.	Red and white sand with pieces of battered metallic iron, doubtless from the drill	15 "
28.	Red shale	40 "
29.	Mainly white quartz sand, but tinted red by bits of shale and other red grains; contains bits of metallic iron	75 "
30.	The same but more red	50 "
31.	The same; the shale is soft and has a red powder, like hematite	110 "
	Total depth	1160 feet

This well flows about one hundred gallons per minute and raises the water fourteen feet above the surface. There seems to be a very small portion of salt in the water. We all expected to get a large flow at Hastings, and were greatly disappointed at the result.

The Red Wing well is at and on the same level as the depot of the Chicago, Milwaukee & St. Paul railway and hence six hundred and eighty-seven feet above the sea. It was drilled by Mr. W. E. Swan, and the information below is derived entirely from him. It begins and ends in the St. Croix formation.

No. 1.	Sand and gravel	40 feet.
" 2.	Sandy shale	10 "
" 3.	Blue shale	50 "
" 4.	Sandrock	10 "
" 5.	Blue shale	30 "
" 6.	A mixture of sand, quartz and limerock	45 "
" 7.	Soft sandrock	265 "
	Total	450 feet.

"This well flows eight hundred gallons a minute at the surface, above which its water rises, when confined in a pipe, to the height of seventy-five feet. It is the largest flow for the depth that I have seen in my experience of twenty-one years. It began to flow over at one hundred and ninety feet from the surface and kept on increasing to the end. We stopped drilling in [at] the red sandrock. I have no faith in getting an increase of water after we strike it, as it always gets very hard, so that we cannot drill more than sixteen feet in twenty-four hours, while in the sandrock where we get our flow, we have sometimes drilled from five to fifteen feet an hour." *

The Well at Lake City was also drilled by Mr. W. E. Swan. He has supplied the survey with a series of the drillings in bottles. His designations were published in the Museum report for 1881, [tenth annual report, p. 161], and are here repeated with such corrections as a study of the drillings requires. This well passes through a considerable thickness of drift, showing the great depth of the Mississippi gorge at that place, being at least two hundred and ten feet below the top of the well. The depot at Lake City is seven hundred and five feet above the sea. and this well is on the same level, and forty-one feet above the low water level of lake Pepin. The well begins in the St. Croix formation.

1.	Black soil	2 feet.
2.	Yellow clay	40 "
3.	Gravel and sand	160 "
4.	Fine loam-clay	5 "
5.	Sand, this seems to be the beginning of the rock	18 "
6.	Coarse sand	7 "
7.	Sand	208 "
8.	Sand, rusty or stained with light red shale	5 "
9.	Sand, very coarse, white grains often fractured.	15 "
10.	Sand, stained with red shale, and with flesh red grains	35 "
11.	Sand.	5 "
12.	Red shale and sand; shale is soft and has a red powder	230 "
	Total depth	820 feet.

* Col. Wm. Colvill says that at Christ's Brewery, Red Wing, is a deep well that spouts three hundred barrels per day, rising thirty feet above the surface—one hundred and sixty feet in drift and one hundred feet in sandrock—eighty rods west of the Milwaukee depot and three rods south of the track and thirty feet above it.

The artesian well at Brownsville, in Houston county, was an experiment for increasing the supply of water to the grist mill of Messrs. Shaller Brothers. According to Mr. Swan, who drilled the well, the discharge is 1,000 gallons per minute, soft water, and granite was reached at 590 feet, where the work ceased. The mouth of this well may be 25 feet above the Mississippi river, or 650 feet above the sea, and the water rises 12 or 14 feet above the surface of the ground. The Potsdam seems here to have been wanting, and the St. Croix deposited unconformably upon the granite.

No. 1.	Blue clay	40 feet.
No. 2.	Limestone. [Doubtful, probably a dolomitic grit — N. H. W.]	25 feet.
No. 3.	Blue shale	60 feet.
No. 4	Green shale	70 feet.
No. 5.	Sandrock	395 feet.
	Total	590 feet.

The first well drilled at the St. Paul Harvester Works, in 1882, was in the rattling, or chipping, room of the foundry, at a height of about fifteen feet above Phalen creek near by, or about 863 feet above the sea.* This well was drilled by N. W. Cary, to the depth of 582 feet (claimed by Mr. Cary to be 602 feet), when his work ceased. In the winter of 1882-3 it was continued, by a diamond drill, under the management of Joseph Susor, to the depth of 626½ feet. The only samples preserved from this well, so far as known, were from the part drilled by Mr. Susor. They are from 10, 20, 30, and 44 feet below 582 feet. These are pulverized, darkish gray, shaly, siliceous, probably dolomitic, agreeing with the core obtained from the second well at a corresponding depth. Owing to the supposed bed of iron and iron ore (reported to be very hard to drill), in the first well *a second one was drilled*, at a point about fifteen rods north from the first, on land about eight feet higher, or approximately 871 feet above the sea. Mr. Cary drilled in this well, during the summer and autumn of 1882, to the depth of 515½ feet. Mr. Susor, with a diamond drill, penetrated 156 feet further, or to a total depth of 671½ feet. A very complete set of the samples from this well

*The railroad at the Union Depot, St. Paul, is 701.5; water in Phalen creek, at the highest crossing of the St. Paul, Stillwater and Taylors Falls Railroad, 845; water in this creek at the Harvester Works, 848; Phalen lake, 854. Concerning the alleged discovery of a deposit of metallic iron and magnetic iron ore in this well, beginning at the depth of 560 feet, and reaching below at least 42 feet, see the *Pioneer Press* for August 24, 1882.

were courteously supplied by Mr. Kirk, from the drillings preserved in the office of the Harvester Works at St. Paul. Mr. Cary drilled a hole six inches in diameter; the core obtained by the diamond drill is about an inch in diameter. The water stands constantly in each well at 35 or 40 feet below the surface. The following descriptions of these drillings are essentially as prepared by Mr. Upham. Rock was reached at 235 feet.

No.	1.	Dark, sandy and clayey loam	1–10 feet.
"	2.	Gray sand and fine gravel containing pebbles up to three-quarters of an inch in diameter	10–20 "
"	3.	Same, with pebbles up to one and a half inches in diameter	20–30 "
"	4.	Yellowish coarse sand	30–40 "
"	5.	Yellowish sand and gravel, with pebbles up to one-half inch	40–50 "
"	6.	Yellowish sand and fine gravel	50–60 "
"	7.	Light gray sand and fine gravel	60–70 "
"	8.	Light gray sand and fine gravel	70–80 "
"	9.	Light gray sand and fine gravel	80–90 "
"	10.	Light gray, fine sand and pebbles up to one and one-half inches, slate, greenstone, etc	90–100 "
"	11.	Light gray, fine sand and pebbles up to three-quarters of an inch, including some of granite	100–110 "
"	12.	Light gray sand and gravel, with small pebbles of granite, greenstone, etc	110–120 "
"	13.	Light gray sand and gravel, with small pebbles up to one-half inch	120–130 "
"	14.	Light gray sand and fine gravel	130–140 "
"	15.	Light reddish gray sand, with rare green stone pebbles up to one and one-half inches in diameter	140–150 "
"	16.	Light reddish gray sand, with pebbles (rare) up to two inches in diameter	150–160 "
"	17.	Light reddish gray sand, with pebbles up to one and one-half inches	160–170 "
"	18.	Light gray sand, with pebbles up to one inch in diameter	170–180 "
"	19.	Coarse gravel, largely made up of pebbles (from the northeast) up to one and one-half inches	180–190 "
"	20.	Similar to last but containing more sand intermixed	190–200 "
"	21.	Same, mostly finer, but with occasional pebbles up to two inches, (one a reddish porphyry, from Lake Superior)	200–210 "
"	22.	Coarse gravel, mostly pebbles up to two inches, with little sand	210–220 "
"	23	Yellowish sand, with few gravel stones, (these probably from the stratum above)	220–230 "

" 24.	The pulverized drilling contains a large proportion of broken, angular fragments (up to one-third of an inch) of buff magnesian limestone (with some sand and gravel stones); the rock is said to have been struck at two hundred and thirty-five feet...............	230–240	"
" 25.	Light yellowish, very fine powder, slightly caked in the box, including no coarse particles or fragments; effervescing freely..	240–250	"
" 26.	Light buff; drillings intermediate in character between the last two..	250–260	"
" 27.	Similar to last, but more arenaceous, mainly very fine, granular (fractured), angular (also containing sand and occasional small pebbles, doubtless from above two hundred and thirty-five)................................	260–270	"
" 28.	Light buff magnesian limestone, in fine (from dust up to one-twelfth of an inch) angular fragments, with grains of rounded quartz..................................	270–280	"
" 29.	Magnesian limestone, yellowish buff, containing a considerable proportion of white quartz particles, some of them rounded by water, up to one-twentieth of an inch in diameter, with arenaceous chert and quartz geodes..	280–290	"
" 30.	Mostly very fine yellowish powder (dust) nearly like No. 25, but also containing frequent angular particles up to one-quarter of an inch in diameter, of magnesian limestone..	290–300	"
	[The samples from three hundred to three hundred and fifty were wanting and could not be found nor learned of. This part is probably limestone, which lies both above and below.]		
" 36.	Mostly fine, light gray powder, with angular fragments up to one-eighth of an inch, of fine grained magnesian limestone that effervesce freely	350–360	"
" 37.	Sandstone; light yellowish, fine, largely (half or more) composed of white quartz grains, well rounded, up to one-thirtieth of an inch in diameter, with dolomitic powder..	360–370	"
" 38.	Limestone; light yellowish buff, nearly like No. 36, excepting color..	370–380	"
" 39.	Sandstone; light gray; all the grains water-rounded mostly one-sixtieth to one-twentieth of an inch in diameter, or finer; none coarser than one-twentieth of an inch...	380–390	"
" 40.	Same as last, mostly beautifully rounded white quartz grains, with pieces of coal, metallic iron and furnace slag..	390–400	"
" 41.	Same as last, becoming more yellowish, with a few bits of coal and battered scales of metallic iron.............	400–410	"
" 42.	Same, with a few grains of shining black coal and scales of metallic iron, the latter largely oxydized...	410–420	"

"	43.	Same, but finer and whiter; grains not exceeding one-fortieth of an inch, all well rounded, with some pyrite, and a few iron scales	420–430 "
"	44.	Same as last; very light yellowish, with slight traces of coal and iron scales	430–440 "
"	45.	Same as the two preceding, with a few grains of pyrite with grains of rounded quartz firmly cemented to them and scales of iron	440–450 "
"	46.	Still finer water-worn sandstone, very light gray, almost white	450–460 "
"	47.	Coarse (up to one-twentieth of an inch), with much also that is very fine; yellowish gray; well water-worn, with iron scales (rusted) and grains of a black scoria; also contains traces of green shale and some dolomitic powder	460–470 "
"	48.	Very fine; very light yellowish; well rounded; much like No. 46, with coal (anthracite), one piece being three-tenths of an inch in diameter; scoria and scales of iron	470–480 "
"	49.	Very fine; light leaden gray, arenaceous (and perhaps dolomitic) shale; (caking somewhat in the box) effervesces	480–490 "
"	50.	Very fine (more so than last) light dusky gray, arenaceous shale; caking harder than the last	490–500 "
"	51.	Similar to the last but more arenaceous, with much sand of white quartz, up to one-hundredth of an inch in diameter	500–515 "

[At five hundred and fifteen feet the pulverized drillings stop, and the remainder of this well is represented by samples of the core of the diamond drill, about one inch in diameter.]

Core from Diamond Drill.

At 555 feet.
"Core at 40 feet (six inches" of core).

Gray, compact and hard, fine-grained sandrock, probably dolomitic; inclosing occasional shaly, darker laminae, and having in some portions dark specks of greensand.

At 578 feet.
"Jan. 1st, 1883; at 63 ft.,—18 inches of core."

Same as the preceding.

At 590 feet.
"75 feet—12 inches of core."

Light yellowish buff, compact and hard, very fine grained sandrock, probably dolomitic; containing mica scales (?) [very minute shining facettes]; (not shaly and having less greensand.)

At 626 feet.
"111 feet—11 inches of core."

Similar to the last, but with light green streaks and irregular blotches, up to one-quarter of an inch thick, vertically, yet not more than three-quarters of an inch long, thinning at each side to one-twentieth of an inch or less in thickness; some fine shale.

At 650–660 feet. "Jan. 8th. This is from 135 to 145 feet. JOSEPH SUSOR." (About 5 feet of core.)	Hard and compact, alternately arenaceous and shaly, probably dolomitic; in color about one-tenth part buff; about one-half dusky gray; and about two-fifths dark green. The layers of dark greensand not so hard as the other portions, vary from one-twentieth of an inch to two or three inches in thickness, being interbedded with the dusky and buff layers

The deep well at Elevator B., St. Paul, is situated near the centre of the southwest quarter of the southeast quarter of section twenty-five, about three and one-half miles west from the Harvester Works wells, beginning about eight hundred and fifty-five feet above the level of the sea. The drillings from this well were examined by Mr. Upham, through the courtesy of Mr. W. S. Zimmerman. The entire depth is eight hundred and fifty feet, drilled by N. W. Carey. Water stood at thirty-five feet below the surface during the entire progress of the work.

1.	Dark gray, fine sand, at 40 feet.		
2.	Dark gray, fine sand	40–58	feet
3.	Light gray, shaly limestone	58–63	feet.
4.	The same	63–69	"
5.	Light yellowish gray, very fine grained, arenaceous (?) shaly	69–83	"
6.	Fine grained, white sandstone	83–235	"
7.	Light gray; somewhat argillaceous, fine grained, apparently sandstone	235–265	"
8.	Buff magnesian limestone in angular fragments	265–300	"
9.	Fine grained, white quartz sandstone, water-rounded	300–320	"
10.	Buff magnesian limestone	320–335	"
11.	Fine, light yellowish powder, no grains visible	335–375	"
12.	White sandstone, in small part iron rusted, water-rounded	375–436	"
13.	Light buff, gritty stone, like the core of the diamond drill in the Harvester Works well	436–437½	"
14.	Sand, light gray, or nearly white	437½–478	"
15.	Light gray shale	478–515	"
16.	Very fine bluish shale	515–523	"
17.	Very fine, light gray shale	523–529	"
18.	Very fine, light yellowish gray sandstone, somewhat argillaceous	529–540	"
19.	Very fine sandstone, with some dark green grains	540–560	"
20.	Very fine shale. olive green	560–589	"
21.	Nearly the same as the last, with some sand	589–604	"
22.	Light gray shale, with some sand	604–672	"
23.	Fine grained sandstone, dark gray	672–738	"
24.	Light gray shale, very fine grained	738–761	"
25.	Unknown	761–850	"

The well at the Harvester Works apparently struck the St. Lawrence, the depth to the rock indicating the absence of the Shakopee and Jordan. The well at Elevator B exhibits some irregularity. The "blue shale" which at Mendota seems to represent the Shakopee, below a thickness of a hundred and twenty-nine feet of sandstone (including forty-seven feet visible in the face of the bluff), is not mentioned at all. It may have been passed without being noted in the one hundred and fifty-two feet reported as sandrock, or it may be represented by Nos. 7 and 8. In the latter case it would coincide with the recognized dip of the Trenton between Mendota and Elevator B, which amounts to about twenty-five feet, bringing the top of the Shakopee at Mendota at about six hundred and fifty-five feet above the sea level, and at Elevator B six hundred and twenty feet. The underlying white sand (twenty feet) would be the Jordan, which in the Mendota well is reported to be thirty-five feet. This parallelism, however, requires the reduction of the St. Lawrence from one hundred and forty-five feet, reported in the Mendota well, to fifty-five feet as reported in the Elevator B well. The same stratum at Lakewood cemetery is given at eighty-five feet.

Any person who has had occasion to record and compare the reports of well-drillers, or to obtain the drillings of wells for his own examination, will appreciate the difficulties and the uncertainties of such records. The drillings are not carefully preserved; the depths from which they are obtained are not accurately stated, nor even known, and the changes in the rock from stratum to stratum cannot be located with precision. Some broad stratigraphic distinctions can generally be made out.

In the case of the wells foregoing it seems necessary to state that the Shakopee formation dwindles toward the north and northeast in this latitude, as already well known further south. The sandy and clay constituents increase at the expense of the calcareous. This is true also of the St. Lawrence, which at Hastings, and apparently at Stillwater, embraces one or more strata of white sand from ten to twenty feet in thickness. These are comparable to these thinner beds of white sand that are intercalated in the Shakopee, seen at Northfield.

MAP OF MINNESOTA.

Showing the Location of the Counties.

Total area 84,286 square miles.

IX.

FOSSILS FROM THE RED QUARTZYTE AT PIPESTONE.

About the middle of October, on the occasion of a visit to Pipestone to obtain specimens for the World's Cotton and Centennial Exposition at New Orleans, in a cursory examination of a lot of the pipestone material in the possession of Mr. C. H. Bennett, certain markings were noticed that had the aspect of small fossil shells, and on some further search several slabs were found which had great numbers of the same impressions thickly scattered over the surface of the bedding side. Subsequently other slabs were found at the Indian quarry which had the same marks freshly exposed by recent operations at the quarry.

These fossils occur in the blood-red catlinite, which is the only kind used by the Indians, though it is possible that they can be found also in the light-colored slabs. They consist of thin lenses about six millimetres in diameter, imbedded in the otherwise homogeneous pipestone. They might be taken for inorganic flattened concretions were it not that they exhibit indistinctly some evidences of organic structure, and when they are removed, along with more or less of the pipestone material, the portion removed, embracing the powdered white scales, shows, on chemical analysis, the presence of phosphate of lime.

Subsequently Mr. A. W. Barber, of Yankton, Dakota, found a trilobitic form among the debris of the old Indian quarry, and it is described below, with his name, as a specific designation.

LINGULA CALUMET.

The shell, so far as can be determined by the fossil remains, was very thin and fragile, containing some phosphate of lime, and nearly circular, averaging somewhat less than a quarter of

an inch across. When freshly uncovered it is of a light flesh color, and resembles the light colored spots that have often been mentioned in the blood-red catlinite, but is much lighter. That these light spots, however, are distinct from those, and different, is evident at a glance. Those light spots have no constant form nor size within the rock. They vary from the size of pin-points to areas covering several inches. They are not so related to the structure that they are uncovered by splitting the rock along its bedding planes, but are as likely to be exposed by a fracture across the bedding. They do not wear away readily by friction, but enter the mass of the rock, while these are so thin that a short exposure to the weather destroys them, leaving only the outline of the shell, either the interior or exterior, outlined in the blood-red catlinite. A section across them is all of the same color; that across these shows a thin scale of the light colored matter embracing a small lenticular mass of the same aspect as the main mass of the rock, of a blood-red color. Those are disseminated porphyritically through the mass of the rock; these lie only in thin sheets (apparently only in one plane) coincident with the bedding, their flatness being in that direction in which a thin bivalve would necessarily lie on the bottom when acted on by sedimentation.

These lenticular bodies, when both valves are preserved in apposition, are about one-half millimeter in thickness; and when only one valve is present there is only the form of the shell preserved, with the merest trace of a scale, that probably represents the shell itself.

There is in some instances a very indistinct, rude, lamellose, concentric marking on the exterior. On the interior of the valves, *i. e.*, on the concave impressions, there is quite frequently a distinct, marginal, flat band, which is separated from the central part by a faint ridge. This ridge may have marked the limit of the general visceral cavity.* The beak of the longer valve is rarely seen in its prolongation beyond the other valve; but there is very often an impression that shows a decided elongation of the shell, such that it could not be described as circular. The smaller valve approaches nearer the circular form. The following figures show some of these features, magnified two diameters. Most of those indistinct markings are similar to

* The appearance of this marginal ridge, in its undulating course, is very similar to that represented in *Obolus Apollinis*, by fig. 282, pl. ix, of Davidson's Introduction to British Fossil Brachiopoda, vol. 1.

those of *Lingula inchoans*, Barr., illustrated by figures 74 and 75 of Barrande's *Faune silurienne des environs de Hof*, en Baviere. This shell, however, is about double the size of that.

EXPLANATION OF FIG. 6.—PLATE I.

Fig. a. Impression of the beak of the longer valve (concave).
Fig. b. Impression of the shorter valve (concave).
Fig. c. Convex surface of a small specimen.
Fig. d. Concave impression of the longer (?) valve.

Locality and position. In the catlinite at the great pipestone quarry, in Pipestone County. Museum register number, 5559. Collector, N. H. Winchell.

PARADOXIDES BARBERI. (N. SP.)

The specimen found by Mr. Barber has been crushed and folded upon itself by some pressure obliquely applied from the right and somewhat from the rear, so that the pleuræ of the left side are turned underneath the animal, but exhibit their furrows and ridges alternately to the number of fourteen or fifteen furrows, separated by as many ridges. The segments of the axis are thus thrust forward over the crumpled pleuræ of the left side, showing more or less of the articular portion of several of the segments. The specimen shows but slight traces of the original crust of the animal. At several places, however, and particularly in the sheltered joints along the axal furrows, small fragments of a thin, red, shining covering remain. The specimen has long been weathered. It is much roughened by the exposure, and injured as a fossil by this fact. It has been in contact with the camp fires of the Indians, as evinced by the blackened condition of the under surface.

The cephalic shield, including the glabella, is wanting; but there are two or three furrows that can be seen to cross the anterior portion of the specimen, as if due to the original furrows of the glabella, and another terminates before reaching the middle. Whether this termination of one of these furrows be due to the pushing together and overlapping of the segments under oblique pressure, or to an actual and natural character of the shield, cannot be ascertained. The whole left side, and much of the central lobe, throughout the thoracic portion, are obscured by the same accident. The accompanying figure (7) of plate I. ex-

presses the character of this fossil better than any description that can be written of its visible characters. About fourteen ridges can be counted on the under side, expressing the number of the pleuræ folded beneath. But in advance of these fourteen are about two more on the upper surface, some of them exhibiting a tendency to duplication, caused by the pleural grooves. The thoracic segments may be considered to have reached sixteen, at least. On the right side from twelve to fourteen segments can be counted, although there are several that are narrow and seem to be due to the crushing down of the right side by an oblique pressure on the pleural grooves.

It is possible that this specimen belongs to some described species, but it would plainly be premature to assign it to any known species at present. It is thought best to give it the name of Mr. A. W. Barber, who discovered it, and await the finding of better material to correct any error. The figure is drawn of the natural size.

Position and locality. The catlinite layers at Pipestone; collected by A. W. Barber. Museum register number, 5555.

The following letter was received from Mr. S. W. Ford, who for some years has been at work on a similar fauna found in eastern New York, and is familiar with obscure forms of organic remains under such circumstances.

S. W. Ford on the pipestone fossils.

SCHODACK LANDING, RENSSELAER COUNTY, N. Y.,
February 14th, 1885.

Prof. N. H. Winchell,

MY DEAR SIR: I have examined with deep interest, and on several different occasions, the supposed fossils from your "red pipestone" rocks of Minnesota, which you kindly submitted to me for study, and have no hesitation in pronouncing them organic. I have endeavored to study the specimens without bias or prejudice; indeed I think I can safely say that my mind has been uninfluenced by any prepossessions concerning the age of the terrane affording them, although aware from the perusal of your writings, as well as those of others, that the disposition has been rather strong of late years, to rank the quartzite as "Huronian."

Your principal specimen (No. 5555) I believe to be a trilobite and most probably a *Paradoxides*, although it may possibly represent the somewhat newer primordial genus *Olenellus*. The specimen has been distorted by pressure exerted obliquely across it from behind, forcing the extremities of the left hand posterior pleuræ underneath and diagonally across the body-axis, and

carrying the axis itself a little to the left. The cephalic shield is wanting. There appear to be from twelve to fourteen body-rings represented, and there are indications that the higher of these figures would be below the actual number in the individual if complete. Along the forward left hand portion of the specimen, there are patches of what I believe to be the altered test of the creature still remaining. The thickness of these films agrees well with the known thickness of the test in trilobites of the genera *Paradoxides* and *Olenellus*. I may add that I also noticed in my study of the body-rings evidences of the usual "articular folds" of trilobites.

The other specimens appear to me to be most probably *Lingulæ*, and the examples to which I have attached tags, or pointers, seem decisive upon this point.* But what the species may be I have no idea. The specimens are all in the condition of casts, and although at first disposed to think that the peculiar pitting noticed in the rostral portion of some of the examples, pointed to *Siphonotreta*, I have since been able to satisfy myself that they are only the casts of sand grains in the pipestone. I have in my collection from the "Acadian" of New Brunswick, slabs crowdedly covered with *Lingulæ* of small size which strikingly suggest a like age for your specimens, and while I cannot feel sure of my position, owing to the imperfection of the materials studied, I am, nevertheless, strongly impressed with the belief that your red "pipestone" fossils are most probably "Acadian."

It affords me much pleasure to add that the results of my examination of your specimens sustain, for the most part, the views you were disposed to take of their generic relations, as expressed in your letter of the sixth instant, accompanying them.

Thanking you for your courtesy and kindness,

I remain, dear Professor,

Very truly yours,

S. W. Ford.

The following is an extract from a letter from Prof. J. D. Dana, respecting these fossils:

New Haven, Ct., February 25, 1885.

Prof. N. H. Winchell,

Dear sir: I am much pleased to have had the privilege of seeing your catlinite fossils. There appears to be no mistake about them, and the little, nearly circular shell, is, as you say, closely like *Lingula*, as far as its characters are discernible. The trilobite might be considered a doubtful fossil, or doubtful whether or not a fossil, were it not associated with other species. But as the case stands there is no good reason for doubting it, and it is an exceedingly interesting find. I believe in fixing the age of even crystalline rocks by fossils, and that has been my heresy; and I am glad that you are having success in that direction. There are some Archæan rocks that have Archæan stamped on them — those that contain chondroditic limestones, and abound in hornblende, scapolites and zircons. But many of them are of ambiguous character, and need to have somewhere an overlying bed of unmistakable primordial (Cambrian) to make their Archæan age certain. . . .

Yours truly,

James D. Dana.

* One of these is b of figure 6, plate I. — N. H. W.

It is well known, from the researches of Wm. E. Logan and T. Sterry Hunt, that the composition of the shells of recent and fossil Lingulæ is made up to a considerable extent of phosphate of lime.* For the purpose of comparison a specimen was handed to Prof. Dodge, who has made the following report:

Prof. James A. Dodge, on the composition of the shells of the fossil Lingulæ from Pipestone.

THE UNIVERSITY OF MINNESOTA,
CHEMICAL LABORATORY.

MINNEAPOLIS, MINN., Feb. 11, 1885.

Prof. N. H. Winchell,

DEAR SIR: I have made an analysis of the white shell-like substance found on the surface of a specimen of pipestone (Chem. series No. 173), as requested by you a few days ago. I find it to consist *esentially of carbonate of lime* but with distinct *traces of phosphate of lime.*

Very respectfully yours,
JAMES A. DODGE.

The discovery of primordial fossils in the pipestone of Minnesota makes an important datum for calculating the stratigraphy of other rocks of the Northwest. This "pipestone" is a part of the great series of quartzytes which by C. A. White was styled *Sioux Quartzyte* in his final report on the geology of Iowa, in 1870. These quartzytes are conspicuous at several other places in Minnesota, and also in Wisconsin, where they have been denominated *Baraboo quartzyte* and placed in the "Huro nian." Prof. James Hall, in 1867, and Mr. J. H. Kloos, in 1871, classed the quartzytes of southwestern Minnesota in the "Huronian." These fossils place them within the "primordial zone" of Barrande, a geological stage which has not yet, confessedly, been covered by the term "Huronian" at any point in America. The Paradoxides horizon, which seems to be here indicated, has been distinguished by the name *St. John's group*, or *Acadian*, and embraces the slates at Braintree, Mass. It is supposed to lie below the *Georgia slates* of Vermont, containing Olenellus, and those to be below the "red sandrock," which is the proper *Potsdam* horizon of the east. The Potsdam horizon of the Wisconsin geologists lies still higher in the primordial, and is allied, in its paleontology, to the Calciferous sandrock. It has but recently been known to exist in eastern New York. Mr.

**American Journal of Science.* (2) xvii, 237.

porphyries of the *Cupriferous series* of the north shore of lake C. D. Walcott has named a number of fossils from it in the Twenty-third Regents' Report on the New York State Cabinet, collected near Saratoga.* These are from a dolomitic limestone which he considers the *Calciferous*, and, indeed, probably is the same that has been so known. Thus it becomes necessary either to abandon the Calciferous in the East as a paleontological division, extending the *Potsdam* horizon upward so as to cover it, or to abandon the claim that the Potsdam, so called by the Wisconsin geologists, as exposed along the Mississippi river, is the true Potsdam. This dilemma was pointed out in 1872, by the writer, in the first report of the survey, and again enforced in the tenth, after this discovery of Mr. Walcott had been made known.

Further, the extension of the primordial zone so much further downward in the Northwest, on the evidence of discovered primordial fossils in the red quartzyte, allows ample room for the existence of the true *Potsdam* of New York as well as of the *Georgia slate* group, between the *St. Croix* sandstone and the pipestone beds. In several deep wells that have been drilled in central and southeastern Minnesota there has been found, beneath the St. Croix sandstone, without exception, a great thickness of red and green shales, associated with some red sandstone. This sometimes has reached the thickness of nearly four hundred feet, and is succeeded below by a hard, red quartzyte or brownish red rock, fine grained or granular, which has been uniformly supposed to be the equivalent of the red quartzytes that outcrop at New Ulm and in Pipestone county. These red shales perhaps represent the *Georgia slates;* and the red sandstone connected with them, apparently expanding toward lake Superior so as to become the red sandstones there called *Potsdam* by the Wisconsin geologists (and perhaps also the Cupriferous series) may be parallelized with the true Potsdam of New York.

Intimately connected with these red quartzytes in Wisconsin are red gneisses† and felsytes, or felsitic porphyries, the quartzytes being below these rocks, and all presenting evidences of sedimentary origin (*Geol. of Wis.*, vol. ii, p. 514). These are therefore brought within the primordial zone, and can be considered as being near analogues of the red felsytes and quartz-

* Science, III, 136.

† Some of the rock at New Ulm is also a red gneiss, of fine grain.

Superior, and, if of sedimentary origin, modified portions of the *Georgia slates*, the *St. John's group* being represented by the gneissic red quartzytes of Pigeon Point and Waswaugoning Bay, at the very base of the *Cupriferous series*.

X.

THE NEW ORLEANS INDUSTRIAL AND COTTON CENTENNIAL EXPOSITION.

The exhibit of the survey at the *New Orleans Industrial and Cotton Centennial Exposition* is quite extensive. It embraces the following parts:

683 specimens of Minnesota crystalline rock samples.
specimens of other Minnesota rock samples.
56 specimens of Minnesota minerals.*
304 specimens of Minnesota fossils.*
57 specimens of Minnesota mammals (stuffed).
specimens of Minnesota birds (stuffed).
28 specimens of Minnesota soils.
49 specimens of Minnesota plants.
58 specimens of Minnesota woods.
specimens of eggs of Minnesota birds.
21 specimens of Minnesota building stones.
specimens of Minnesota (Red Wing) pottery.
126 specimens of manufactured articles of catlinite.
21 miscellaneous specimens of Minnesota rocks, slates, granites, iron ores, clays, etc.
20 maps of the state, of the scale of ten miles to the inch, designed to show the physical features, geology, distribution of timber, and the main features of climate and soil.
66 meteorites from all parts of the world.
16 bound volumes representing the stated publications of the survey.

The detailed list and description of these articles will be reported to the *Minnesota state board of collective exhibits*, and will be communicated through the state commissioner, Mr. Oliver Gibbs, Jr., to the governor.

* This number expresses the register entries; the specimens were two or three times as many.

XI.

REPORT ON THE MUSEUM FOR 1884.

The following list of additions does not include zoological specimens received since the last report, the number of which is quite large. Many of these are on exhibition at New Orleans, consisting of birds and mammals.

The specimens of plants received by the survey, in response mainly to the circular issued in the year 1876, are specified in the following enumeration. An important donation has been received from the United States department of agriculture, Washington, consisting of 1,194 species of American and foreign plants.

The condition of the museum at present is chaotic, owing to the removal of a large quantity of the specimens to New Orleans. It is expected these will be returned early in June, and they will then be restored to their places in the cases.

Collections of plants in the possession of the Geological and Natural History Survey of Minnesota, April 1, 1885.

1. *U. S. Department of Agriculture,* Washington, D. C. A collection of 638 species of American and 556 species of foreign plants. Presented 1884.

1194 species.

2. *John B. Leiberg.* A collection of Minnesota plants from Blue Earth county. Presented, April, 1883.

78 species.

3. *John B. Leiberg.* A collection of western plants from Dakota and Montana. Presented, August, 1883.

114 species.

4. *Dr. W. E. Leonard.* A collection of Minnesota plants, by the late J. C. Kassube. Presented by Dr. W. E. Leonard, of Minneapolis, Minn., 1884.

440 species.

5. *C. L. Herrick.* Minnesota plants, collected on the Geological and Natural History Survey at various times.

529 species.

6. *B. Juni.* Plants of the north shore of lake Superior. Collected on the Geological and Natural History Survey. August–September, 1878.

175 species.

7. *T. S. Roberts.* Plants of the north shore of lake Superior. Collected on the Geological and Natural History Survey, July–September, 1879.

137 species.

8. *Dr. W. E. Leonard.* Minnesota plants. Collected on the Geological and Natural History Survey, 1875-6.

64 species.

9. *Prof. N. H. Winchell.* Minnesota plants. Collected at various times.

75 species.

10. *H. V. Winchell.* Minnesota plants. Collected at various times.

150 species.

11. "*Ex herbario horti Petropolitani.*" A collection of foreign plants. Presented.

155 species.

12. *Miss Macfarlane.* A collection of plants from southern Labrador. Presented.

25 species.

13. *F. W. Anderson.* A collection of plants from Montana. Presented, February, 1885.

72 species.

14. Through Mr. Warren Upham plants have been presented from the following persons:

Dr. Geo. Vasey, Washington, D. C., 7 species of Aristida and 14 of Panicum.

Prof. C. J. Gedge, Moorhead, Minn.

18 species.

Rev. J. Scott, West Emerson, Manitoba.

24 species.

Dr. J. H. Sandberg, Red Wing, Minn.

5 species.

Mr. R. J. Cratty. Six species of rare plants from Emmett county, Iowa.

In all 3283 species, including duplicates.

SPECIMENS REGISTERED IN THE GENERAL MUSEUM IN 1884.

Serial Number.	OBTAINED.		NAME.	No. of Specimens.	Locality.	Formation.	Collector and Remarks.
	When.	Whence.					
5360	1881.	Geol. and Nat. Hist. Survey	Magnesian limestone (light)	1	Kasota	Shakopee	N. H. Winchell.
5361	1884.	" "	Drift limestone	5	Burnsville, sec. 25, Dak. co.	Drift	" "
5362	"	" "	Sandstone	1	Near Ft. Snelling, Dak. co.	St. Peter	" "
5363	"	" "	"North River bluestone"	2	Rondout, N. Y.		Presented by N. H. Winchell.
5364	"	" "	Red pipestone	1	Near Rice Lake, Barren co., Wis.	Potsdam	Presented N. H. Winchell. (Layer six feet thick.)
5365	"	" "	Purple pipestone	1	" "	"	Presented N. H. Winchell. (3 feet thick, underlying No. 5364.)
5366	"	" "	Quartzyte	3	" "	"	Presented by N. H. Winchell. (Overlying the pipestone—last two numbers.)
5367	"	" "	Pipestone	7	Near Luverne, Rock co.	"	Presented by J. C. Constable. At the base of "The Mound."
5393	Nov., 1883.	" "	Sequoia Winchellii, Lesq., Lesquereux' No. 115	1	Cottonwood River, S. of New Ulm	Dakota	N. H. Winchell. Compare No. 115.
5394	"	" "	Populus elegans, Lesq., Lesquereux' No. 5155 c	1	" "	"	N. H. Winchell. Compare No. 5155.
5395	"	" "	Populus cyclophylla? Heer, Lesquereux' No. 5155 K. P. G	3	" "	"	N. H. Winchell. Compare No. 5155.
5396	"	" "	Populus litigiosa, Heer, Lesquereux' No. 5155 A. A. M	3	" "	"	N. H. Winchell. Compare No. 5155.
5397	"	" "	Populus lancastriensis, Lesq., Lesquereux' No. 5155 D	1	" "	"	N. H. Winchell. Compare No. 5155.
5398	"	" "	Platanus species, Lesquereux' No. 5155 S	1	" "	"	N. H. Winchell. Compare No. 5155.
5399	"	" "	Ficus austiniana, sp. nov., Lesquereux' Nos. 3808 and 5163	2	" "	"	N. H. Winchell. Compare Nos. 3808 and 5163.
5400	"	" "	Laurus plutonia, Heer., Lesquereux' No. 5157 C	1	" "	"	N. H. Winchell. Compare No. 5157.
5401	"	" "	Cinnamomum Scheuchzeri? Heer., Lesquereux' No. 5155 I	1	" "	"	N. H. Winchell. Compare No. 5155.

5402	Nov., 1883.	Geol. and Nat. Hist. Survey	Andromeda Parlatorii, Heer., Lesquereux' No. 5157 A	1	" "	"	N. H. Winchell. Compare No. 5157.
5403	"	" "	Cissus Browniana, sp. nov., Lesquereux' No. 5156	1	" "	"	N. H. Winchell. Compare No. 5156.
5404	"	" "	Magnolia alternans, Heer., Lesquereux' No. 5155 B	1	" "	"	N. H. Winchell. Compare No. 5155.
5405	"	" "	Dewalguea primordialis, sp. nov., Lesquereux' No. 5158	1	" "	"	N. H. Winchell. Compare No. 5158.
5406	"	" "	Protophyllum crednirioides, Lesq., Lesquereux' No. 5155 P	1	" "	"	N. H. Winchell. Compare No. 5155.
5407	"	" "	Sapindus Morrisoni, Lesq., Lesquereux' Nos. 3808 and 3912	2	" "	"	N. H. Winchell. Compare Nos. 3808 and 3912.
5408	June, 1884.	" "	Marl	Indif.	Johnson's Lake, Minneapolis	Drift	N. H. Winchell.
5409	July, 1884.	Mr. Davis	Quartzyte (pinkish white)	1	Garden Valley, Jackson co., Wis	Potsdam?	Presented by M. Davis, of Merillan.
5410	"	Presented	Calamine	1	Endy Mine, Friedensville, Lehigh co., Pa.		From J. Eyerman.
5411	"	"	Sphalerite (gray)	4	" "		" "
5412	"	"	Greenockite	1	" "		" "
5413	"	"	Azurite	1	Cornwall, Lebanon co. Pa		" "
5414	"	"	Malachite	1	Ecton Mine, Shannonville, Pa		" "
5415	"	"	Pyromorphite	1	Wheatley Mine, Phœnixville, Pa		" "
5416	"	"	Galenite	1	" "		" "
5417	"	"	Sphalerite (brown)	2	" "		" "
5418	"	"	Hydrodolomite and chromite	1	Woods' Pit, Lancaster co., Pa		" "
5419	"	"	Hydromagnesite and chromite	1	" "		" "
5420	"	"	Magnesite	1	" "		" "
5421	"	"	Hydrocuprite	1	Cornwall, Lebanon co. Pa		" "
5422	"	"	Limonite ("pipe ore")	1	Wharton Iron Mine, lower Saucon Twp., Northampton co. Pa.		" "
5423	"	"	" (geode)	1	" "		" "
5424	"	"	"	1	" "		" "
5425	"	"	Hematite	1	" "		" "
5426	"	"	" (fossiliferous)	1	Center co., Pa		" "
5427	"	"	" (specular)	1	Isle of Elba		" "
5428	"	"	Tourmaline and quartz	3	Easton, Northampton co., Pa.		" "
5429	"	"	Biotite and talc	1	" "		" "
5430	"	"	Epidote and bl. hornblende	1	Frankford, Philadelphia co., Pa		" "
5431	"	"	Turgite	1	Easton, Nthmptn co., Pa.		" "

SPECIMENS REGISTERED IN THE GENERAL MUSEUM IN 1884.

Serial Number.	OBTAINED. When.	OBTAINED. Whence.	NAME.	No. of Specimens.	Locality.	Formation.	Collector and Remarks.
5132	July, 1884.	Presented	Malachite	2	Arlington, N. J.		From J. Eyerman.
5433	"	"	Quartz (rose colored)	1	Southford, Conn.		" "
5434	"	"	Franklinite, polydelphite, rhodonite, and willemite	1	Franklin, Sussex co., New Jersey		" "
5435	"	"	Wernerite	1	Bolton, Mass.		" "
5436	"	"	Garnet (polydelphite)	1	Franklin, N. J.		" "
5437	"	"	Zircon	1	Renfrew, Ontario, Can.		" "
5438	"	"	Calcite	1	" "		" "
5439	"	"	Fluorite	1	Rosiclare, Ill.		" "
5440	"	"	Iron ore	1	Algiers, Africa		" "
5441	"	"	Amethystine quartz	1	Clayton, Raybun co., Georgia		" "
5442	"	"	Magnetite	1	Verona, N. J.		" "
5443	"	"	Hematite	1	Chester co. lead mines, Phœnixville, Pa.		" "
5444	"	"	Magnetite	1	Essex co., N. J.		" "
5445	"	"	Amphibole (tremolite)	1	Pennsylvania		" "
5446	"	"	Psilomelane	1	Wharton Mine, Northampton co., Pa.		" "
5447	"	"	Franklinite and zincite	2	Franklin, Sussex co., N. J.		" "
5448	"	Geol. and Nat. Hist. Survey	Sandstone (rusty, cemented)	1	N'r Ft. Snelling, Dak. co.	St. Peter	N. H. Winchell.
5449	"	Presented	Building stone block	1	Nininger	St. Law	1 foot by 1 foot 6 inches.
5450	"	"	Oolyte	34	Stillwater		From A. D. Roe.
5451	Aug., 1884.	Geol. and Nat. Hist. Survey	Drillings from the Humboldt salt well — lacustrine clay with lime concretions	1 bottle.	Humboldt, Minn.		N. H. Winchell. (4 to 16 feet.)
5452	"	" "	The same, but darker colored	"	" "		" " (16 to 140 feet.)
5453	"	" "	Pebbly blue till. (Saltwater at 165 feet)	"	" "		" " (140 to 170 ft.)
5454	"	" "	Drift gravel and sand. (More salt water.)	"	" "		" " (170 to 180 ft.)
5455	"	" "	Dolomitic limestone (buff)	"	" "		" " (180 to 190 ft.)
5456	"	" "	Finer drillings of the same	"	" "		" " (190 to 300 ft.)
5457	"	" "	The same, slightly pinkish	"	" "		" " (300 to 400 ft.)

5458	"	" "	Reddish shale or limerock. (Washed drillings of this are mainly limerock.)	"	" "		" " (400 to 475 ft.)
5459	"	" "	Reddish sand of rounded quartz grains	"	" "		" " (475 to 500 ft.)
5460	"	" "	White sand of rounded quartz grains. (Salt water flow increased)	"	" "		" " (500 to 532 ft.)
5461	"	" "	Faintly reddish quartz grains	"	" "		" " (532 to 546 ft.)
5462	"	" "	"Soapstone" shale, red and green	"	" "		" " (546 to 550 ft.)
5463	"	" "	The same, gray in general color	"	" "		" " (550 to 556 ft.)
5464	"	" "	The same, reddish brown	"	" "		" " (556 to 560 ft.)
5465	"	" "	The same, with grains of a white air-slaking mineral, which effervesces in No. 5	"	" "		" " (560 to 571 ft.)
5466	"	" "	The same, but lighter colored	"	" "		" " (571 to 592 ft.)
5467	"	" "	Greenish gray shale, the same as No. 13	"	" "		" " (592 to 610 ft.)
5468	"	" "	Greenish gray shale, containing bits of grayish quartzyte, that feebly effervesces in H. C. L.	"	" "		" " (610 to 635 ft.)
5469	"	" "	The same unwashed	"	" "		" " (635 to 638 ft.)
5470	"	" "	Greenish gray, foliated, micaceous quartz-schist, washed	"	" "		" " (638 to 639 ft.)
5471	"	" "	Quartz, feldspar, and mica, washed	"	" "		" " (639 to 641 ft.)
5472	"	" "	Quartz, feldspar, and mica, washed	"	" "		" " (641 to 644 ft.)
5546	1880.	" "	Columnaria alveolata (Gold)	1	Near St. Charles	Trenton	" "
5549	"	" "	Orthis whitfeeldi (Winch)	15	Spring Valley, l. m. e.	"	" "
5555	1884.	" "	Paradoxides barberi (Winch)	1	Pipestone county	Acadian	From A. W. Barber.
5556	"	" "	Chlorastrolites	Indif.	Isle Royal	Cuprif.	Purchased. (In two vials.)
5557	"	" "	Thomsonites	"	Grand Marais	"	" (In a vial.)
5558	"	" "	Hematite	9	Vermilion mines	Archa.	N. H. Winchell.
5559	Nov., 1884.	" "	Slabs of catlinite, showing forms like small Lingulæ	Ind.	Pipestone quarry	Potsdam	" "
5560	1883.	" "	Clay pebbles	"	Princeton	Drift	U. I. Small.
5561	1883.	N. H. Winchell	Trap rock	3	Orange Mt., N. J.	Archa.	Presented by N. H. Winchell.
5562	"	" "	Felsyte	3	High Rock, Lynn, Mass.		" "
5563	"	Geol. and Nat. Hist. Survey	Silicified fossils, from the Cret. conglomerate	31	Red Jacket Bridge, nr. Mankato		N. H. Winchell.
5564	"	" "	Series showing passage from magnesian schist to hematite	4	Vermilion iron mines	Archa.	"
5565	"	Geo. C. Stone	Hematite, from Stuntz mine	1	" "	"	Presented by Geo. C. Stone.
5566	"	" "	" " Ely mine	1	" "	"	" "
5567	"	" "	" " Stone mine	1	" "	"	" "
5568	"	" "	" " Lee mine	1	" "	"	" "
5569	"	" "	" " Tower mine	1	" "	"	" "
5570	"	" "	" " Breitung mine	1	" "	"	" "
5571	"	" "	" " Armstrong mine	1	" "	"	" "
5572	"	D. S. Martin	Lignite	4	Disco Island, Greenland		" D. S. Martin.
5573	"	" "	" mainly organic	2	Bahia, Brazil		" " (Used for making gas New York.
5574	"	Geo. F. Kunz	Native antimony	1	Prince William, York co., New Brunswick		Presented by Geo. F. Kunz.

SPECIMENS REGISTERED IN THE GENERAL MUSEUM IN 1884.—(Continued.)

Serial Number.	OBTAINED. When.	OBTAINED. Whence.	NAME.	No. of Specimens.	Locality.	Formation.	Collector and Remarks.
5575	1884.	A. A. Julien	Sonorous sand		Atlantic shore		Presented by A. A. Julien.
5576	"	B. Juni	Wood from a well 116 feet deep	Ind.	New Ulm, Minn	Drift	" B. Juni.
5587	Aug., 1884.	B. W. Thomas	Sporangites Huronensis, Daw	"	Chicago, Ill	Devon	" B. W. Thomas, Chicago, boulder clay.
5588	Dec., 1884.	A. W. Barber	Crocidolite	1	South Africa		Presented by A. W. Barber.
5589	June, 1884.	Prof. W. F. Phelps	"White iron" and arsenical sulphuretes, carrying gold	1	Bear Gulch, Mont		" Prof. W. F. Phelps.
5590	"	" "	Lava from H. O. W. copper mine	1	Black Hills, Dak		" "
5591	"	" "	Gold bearing quartz, carrying iron pyrites	1	Bear Gulch, Mont		" "
5592	"	" "	Silver ore (sulphide)	1	Vienna Mine, Idaho		" "
5593	"	" "	Silver sulphide	1	" "		" "
5594	"	" "	Argentiferous galena	1	Black Hills, Dak		" "
5595	"	" "	Galena and silver ore	2	Near Maiden, Mont		" "
5596	"	" "	Galena and silver	1	Concord mine, Maine		" "
5597	"	" "	Argentiferous galena	1	Montana		" "
5598	"	" "	Copper bearing quartz	1	Belt Range, Mont		" "
5599	"	" "	Oxide copper	3	Black Hills, near Sheridan, Dak	Cup	" "
5600	"	" "	"	1	Black Hills, Dak	"	" "
5601	"	" "	Carbonate copper in quartz	2	Belt Mts., Mont., near Livingston	"	" "
5602	"	" "	Carbonate copper	4	Black Hills, n'r Sheridan.	"	" "
5603	"	" "	Green carbonate and oxide of copper	2	Black Hills, Dak	"	" "
5604	"	" "	Carbonate of copper from shaft 25 feet	11	" "	"	" "
5605	"	" "	" " from open cut	8	" "	"	" "
5606	"	" "		1	Belt Mts., Mont		" "
5607	Jan., 1884.	Presented	White sandstone	2	Lansing, Iowa		" by J. M. Turner.
5608	1884.	" "	Group of quartz crystals	1	Ozark Mts.		" Hon. Richard Chute, obtained at Hot Springs.
5609	Sept., 1883.	Geol. and Nat. Hist. Survey	Darkish gray, shaly, siliceous, and probably dolomitic. First well	1 bottle.	St. Paul, Minn		W. Upham (500–525–582 feet.)
5610	"	" "	The same. First well	"	" "		" No. 2 (500–525–582 ft).

5611	"	"	"	" "	"	"	"	Drillings from the Harvester Works Well.	"	(582–592 feet.)
5612	"	"	"	" "	"	"	"		"	(592–602.)
5613	"	"	"	" "	"	"	"		"	(602–612.)
5614	"	"	"	" "	"	"	"		"	(612–626.)
5615	"	"	"	Dark, sandy, and clay loam. Second well	"	"	"		"	(1–10 feet.)
5616	"	"	"	Gray sand and fine gravel. Second well	"	"	"		"	(10–20.)
5617	"	"	"	Same, with pebbles up to 1½ in. diam. Second well	"	"	"		"	(20–30.)
5618	"	"	"	Yellowish, coarse sand. Second well	"	"	"		"	(30–40.)
5619	"	"	"	Yellowish sand and gravel. Second well	"	"	"		"	(40–50.)
5620	"	"	"	The same (fine gravel). Second well	"	"	"		"	(50–60.)
5621	"	"	"	Light gray sand and fine gravel. Sc'nd well	"	"	"		"	(60–70.)
5622	"	"	"	The same. Second well	"	"	"		"	(70–80.)
5623	"	"	"	The same. Second well	"	"	"		"	(80–90)
5624	"	"	"	Light gray, fine sand and pebbles, 1½ in. diam. Second well	"	"	"		"	(90–100.)
5625	"	"	"	The same, with pebbles ¾ in. Sc'nd well	"	"	"		"	(100–110.)
5626	"	"	"	Light gray sand and gravel. Second well	"	"	"		"	(110–120.)
5627	"	"	"	The same. Second well	"	"	"		"	(120–130.)
5628	"	"	"	The same (gravel fine). Second well	"	"	"		"	(130–140.)
5629	"	"	"	Light, reddish gray sand, with pebbles. Second well	"	"	"		"	(140–150.)
5630	"	"	"	The same, with pebbles 2 in. in diam. Second well	"	"	"		"	(150–160.)
5631	"	"	"	The same, with pebbles up to 1½ in. Second well	"	"	"		"	(160–170.)
5632	"	"	"	Light gray sand, with pebbles ·1 in. in diameter. Second well	"	"	"		"	(170–180.)
5633	"	"	"	Coarse gravel. Second well	"	"	"		"	(180–190.)
5634	"	"	"	Similar to last, but with more sand. Second well	"	"	"		"	(190–200.)
5635	"	"	"	Same, mostly finer. Second well	"	"	"		"	(200–210.)
5636	"	"	"	Same, with pebbles up to 2 in. diam. Second well	"	"	"		"	(210–220.)
5637	"	"	"	Yellowish sand, with few gravel stones. Second well	"	"	"		"	(220–230.)
5638	"	"	"	Fragments of a buff magnesian limestone, with some sand and gravel. Scnd well	"	"	"		"	(230–240.)
5639	"	"	"	Limestone, light yellowish. Second well	"	"	"		"	(240–250.)
5640	"	"	"	Limestone, light buff. Second well	"	"	"		"	(250–260.)
5641	"	"	"	Similar to last. Second well	"	"	"		"	(260–270.)
5642	"	"	"	Light buff magnesian limestone. Sc'nd well	"	"	"		"	(270–280.)
5643	"	"	"	Yellowish buff magnesian limestone. Second well	"	"	"		"	(280–290.)
5644	"	"	"	Yellowish powder, with fragments of magnesian limestone. Second well	"	"	"		"	(290–300.)
5645	"	"	"	Mostly fine, light gray powder, with fragments of magnesian limestone. 2d well	"	"	"		"	(350–360).

SPECIMENS REGISTERED IN THE GENERAL MUSEUM IN 1884.—(Continued.)

Serial Number.	OBTAINED. When.	OBTAINED. Whence.	NAME.	No. of Specimens.	Locality.	Formation.	Collector and Remarks.
5646	Sept., 1883.	Geol. and Nat. Hist. Survey	Sandstone, light yellowish, with dolomitic powder. Second well	1 bottle.	St. Paul, Minn	Drillings from the Harvester Works Well.	W. Upham (360–370.)
5647	"	" "	Limestone, light yellowish buff. Sc'nd well	"	" "		" (370–380.)
5648	"	" "	Sandstone, light gray. Second well	"	" "		" (380–390.)
5649	"	" "	Same, with pieces of coal, metallic iron, and furnace slag. Second well	"	" "		" (390–400.)
5650	"	" "	Same, with coal and battered scales of metallic iron. Second well	"	" "		" (400–410.)
5651	"	" "	The same as last. Second well	"	" "		" (410–420.)
5652	"	" "	Same, but finer and white, with some pyrite and few iron scales. Second well	"	" "		" (420–430.)
5653	"	" "	Same, with slight traces of coal and iron scales. Second well	"	" "		" (430–440.)
5654	"	" "	Same as last. Second well	"	" "		" (440–450.)
5655	"	" "	Sandstone, fine, water-worn. Second well	"	" "		" (450–460.)
5656	"	" "	" coarse, yellowish gray. 2d well	"	" "		" (460–470.)
5657	"	" "	" very fine, light yellow. 2d well	"	" "		" (470–480.)
5658	"	" "	Sandstone, very fine, light, leaden gray. Second well	"	" "		" (480–490.)
5659	"	" "	Sandstone, very fine, light, dusky gray. Second well	"	" "		" (490–500.)
5660	"	" "	Sandrock, gray, compact, and hard, probably dolomitic. Second well	1	" "		" 6 in. of core at 555 ft.
5661	"	" "	Same as the preceding. Second well	3	" "		" 18 in. of core at 578 ft.
5662	"	" "	Sandrock, light, yellowish buff. Sc'nd well.	2	" "		" 12 in. of core at 590 ft.
5663	"	" "	Similar to the last. Second well	9	" "		" 11 in. of core at 626 ft.
5664	"	" "	Sandrock, hard and compact, with layers of dark green sand. Second well	17	" "		" cores f'm 650 to 660 ft.
5665	"	" "	———. Second well	28	" "		" cores, depth not k'wn.
5666	1884.	Presented	Cretaceous leaves	13	Mankato, Minn	Cret.	From Mr. S. F. Alberger.
5699	"	By purchase	Felsyte	1	Minneapolis, Minn	Drift	" W. Howling.
5700	"	"	Asaphus megistos	1	Butler co., O		Prof. C. W. Hall. Cast.
5702	Oct., 1884.	By exchange	Lingula melie, Hall	1	Licking co., O	Cuyahoga sh.	From Prof. C. L. Herrick.

5703	"	" "	Lycopodites vanuxemi, Dow	1	Ithaca, N. Y.	Chemung	" "	
5704	"	" "	Streptelasma corniculum, Hall	1	Dayton, O.	Tr'n & Hud.	" "	
5705	"	" "	Pentamerus oblongus, Sowerby	2	Springfield, Clark co.	Niagara	" "	
5706	"	" "	Strophomena alternata, Conr.	3	Cincinnati, O.		" "	
5707	"	" "	Leptæna sericea	2	Dayton, O.		" "	
5708	"	" "	Allorisma Winchelli, Meek	2	Rushville, O.		" "	
5709	"	" "	Sanguinolites obliquus	2	"		" "	
5710	"	" "	Sperifera mucronata (?)	1	Ithaca, N. Y.	Chemung	" "	
5711	"	" "	Rhynchonella dentata, Hall	2	Dayton, O.	Cincinnati.	" "	
5712	"	" "	" increbescens	2	"	"	" "	Lebanon beds.
5713	"	" "	" "	3	Cincinnati, O.		" "	
5714	"	" "	Orthis biforata	2	"		" "	
5715	"	" "	" occidentalis, Hall (?)	2	"		" "	
5716	"	" "	Streptelasma corniculum, Hall	1	"		" "	
5717	"	" "	Grammysia ventricosa, Meek	1	Rushville, O.		" "	
5719	"	Presented	Endoceras proteiforme, Hall	1	Warren co., O.		From Prof. C. W. Hall.	
5720	"	"	Orthis acutilirata, Conr.	3	Butler co., O.		" "	
5721	"	"	Rhynchonella capax, Conr.	3	"		" "	
5722	"	"	Zygospira cincinnatensis	6	"		" "	
5723	1884.	Geol. and Nat. Hist. Survey	Rusted stone	1	Minneapolis, Minn.		N. H. Winchell.	(At 135 feet.)
5724	"	" "	Quartzose sandstone, composed of rounded grains of pure quartz	Ind.	" "	Drillings from the Lakewood Cemetery Well.	"	(256–276 feet.)
5725	"	" "	The same	"	" "		"	(276–296 feet.)
5726	"	" "	The same	1 bottle.	" "		"	(At 300 feet.)
5727	"	" "	The same	"	" "		"	(At 314 feet.)
5728	"	" "	Dolomitic rock (washed)	"	" "		"	(318–320 feet.)
5729	"	" "	Sand	"	" "		"	(At 320 feet.)
5730	"	" "	White sand	"	" "		"	(At 325 feet.)
5731	"	" "	Slightly red, fine grained, dolomitic rock	Indif.	" "		"	(360–403 feet.)
5732	"	" "	The same, with some mixture of the next (No. 5733)	"	" "		"	(403–416 feet.)
5733	"	" "	Translucent rounded grains of quartz	"	" "		"	(416–424 feet.)
5734	"	" "	The same	"	" "		"	(424–434 feet.)
5735	"	" "	White chert, coated with dolomitic pyrites.	"	" "		"	
5736	"	" "	White quartz sand, rounded	"	" "		"	(434–481 feet.)
5737	"	" "	The same, with traces of light, green shale.	"	" "		"	(481–504.)
5738	"	" "	White quartz sand, rounded, with some green shale	"	" "		"	(504–558.)
5739	"	" "	White sand and green sand	"	" "		"	(558–607.)
5740	"	" "	White sand	"	" "		"	(694–704.)
5741	"	" "	Mainly white sand	"	" "		"	(763–773.)
5742	"	" "	Green clay or shale, non-effervescing, very fine grained	"	" "		"	(780–844.)
5743	"	" "	White sand, with a faint, yellowish tint	"	" "		"	(935–960.)
5744	"	" "	Siliceous sand, with a faint, pinkish tint, rather fine	"	" "		"	(1005–1010.)

SPECIMENS REGISTERED IN THE GENERAL MUSEUM IN 1884.—(Continued.)

Serial Number.	OBTAINED.		NAME.	No. of Specimens.	Locality.	Formation.	Collector and Remarks.
	When.	Whence.					
5745	1884.	Geol. and Nat. Hist. Survey	Siliceous sand, with a deeper pinkish tint and coarser grain	Indif.	Minneapolis, Minn.	Drillings from Lakewood Cemetery Well.	N. H. Winchell. (1010–1050.)
5746	"	" "	The same, but of a lighter color	"	" "		" (1060–1070.)
5747	"	" "	The same, but cemented, when dry, with ground up reddish shale	"	" "		" (1105–1120.)
5748	"	" "	Compact red clay or shale	"	" "		" (1123–1160.)
5749	"	" "	Sand shale of a reddish color	"	" "		" (bet. 1123–1167)
5750	"	" "	Red shale, mottled with light green	4	" "		" (bet. 1123–1167)
5751	"	" "	Reddish brown shale	Indif.	" "		" (1167–1235.)
5752	"	" "	The same	"	" "		" (1235–1260.)
5753	"	" "	The same	"	" "		" (1260–1365.)
5754	"	" "	The same	"	" "		" (At 1400 feet.)
5755	March, 1885.	" "	Gray, tough cryptocrystalline, similar to survey No. 469 or 473	"	" "		" (At 1860 feet.)

Archæological specimens registered in the General Museum in 1884.

112. Flints (three) from about lake Minnewaska, Minn. Presented by Dan. F. Bartke, of Glennwood, Minn., March 14, 1884.

113. One piece of obsidian from lake Minnewoska. Presented by Dan. F. Bartke, of Glennwood, Minn., March 14, 1884.

114. Bit of red substance from stratum, Little Falls, Minn. Presented November 10, 1882, by Frances E. Babbitt.

115. One piece of sonorous *quartz* from stratum, Little Falls, Minn. (they jingle with other *quartz*-like metal). Presented November 10, 1882, by Frances E. Babbitt.

116. Chipped implement (one), from river gravels at the ferry, Little Falls, Minn. Presented November 10, 1882, by Frances E. Babbitt.

117. Piece of nicked *quartz*, perhaps for cutting tendons, etc., from stratum, Little Falls, Minn. Presented November 10, 1882, by Frances E. Babbitt.

118. Piece of a bone. Little Falls, Minn. Presented, November 10, 1882, by Frances E. Babbitt.

119. A small dark chert arrow point, one and a half inches long, notched base. From Battle Creek, Mich. Presented by Mrs. C. H. Crosby, 1883.

120. Arrow point (one), light chert, three and a quarter inches long, notched base. From Battle Creek, Mich. Presented by Mrs. C. H. Crosby, 1883.

121. Gray flint implement (one), four and a half inches long, rounded base. From Battle Creek, Mich. Presented by Mrs. C. H. Crosby, 1883.

122. Stone hammer (one). Sample of those now in use among the Cheyenne Indians, near the Black Hills. Presented by the Rev. L. J. Hauge, Mankato, 1883.

123. Spear head (one), dark chert, four and three-quarter inches long, pointed at both ends. From section 30, township 45, range 28, west of Mille Lacs, Minn. Presented January 5, 1884, by O. E. Garrison.

124. Specimens of pottery (forty-five pieces), from Mille Lacs, Minn. Presented January 5, 1884, by O. E. Garrison.

125. Piece of flint (one) from Mille Lacs, Minn. Presented January 5, 1884, by O. E. Garrison.

126. Implement of brown chert (one), from Mille Lacs Minn. Presented January 5, 1884, by O. E. Garrison.

127. Stone implement (one), from Mille Lacs, Minn. Presented January 5, 1884, by O. E. Garrison.

128. Specimen of tattooing taken from the arm of a cadaver. Presented by Dr. Arthur Eastman.

129. Stone hammer (one), from Illinois. By purchase from Wm. Howling, 1884.

130. Stone hammers (two), from Long Lake, Minnesota. By purchase from Wm. Howling, 1884.

List of books added to the Library of the Geological and Natural History Survey since the publication of the list in the report of 1880.

Proceedings of the Academy of Natural Sciences, of Philadelphia. Parts I and II, January to October, 1879. Purchased.

Proceedings of the Davenport Academy of Natural Sciences. Volume III, Parts II and III, 1879-81. From the Academy.

Transactions of the Edinburgh Geological Society. Volume IV, Part II, 1881-82. Purchased.

Bulletin of the Buffalo Society of Natural Sciences. Volumes I, II, III and IV. Complete. From the Society.

The American Antiquarian and Oriental Journal. Volume IV, No. 1, October, 1881, and No. 4, October, 1882. Volume V, complete. Volume VI, Nos. 1, 3, 4 and 6, 1884. Volume VII, Nos. 1 and 3, January and March, 1885. From the Editor.

Bulletin of the United States Geological Survey. No. 1, 1883. From the Survey.

United States Geological Survey. Mineral resources of the United States. By Albert Williams. From the Survey.

Smithsonian reports for 1863, 1870, 1873, 1875, 1878, 1879, 1881. From the Smithsonian Institution.

Transactions of the Academy of Science, of St. Louis. Volume. IV, Nos. 2 and 3. From the Academy.

Memoirs of the Peabody Academy of Science. Volume I, Salem, Mass. From the Academy.

Report of the Geological Survey of Ohio. Volume IV, Part I. Zoology. From Prof. E. Orton.

Geological Survey of Minnesota. Reports I to VIII, inclusive, 1872-9. One volume. From Mrs. C. M. Terry.

United States Coast and Geodetic Survey. Reports for 1878, 1879 and 1880. From the United States Coast Survey.

United States Geological Survey. Second annual report—1880-81. From the Survey.

Monographs of the United States Geological Survey. Volume II. From the Survey.

Tertiary History of the Grand Canon District, with atlas, by Clarence E. Dutton. From the Survey.

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XII.

NOTES ON THE GEOLOGY OF MINNEHAHA COUNTY, DAKOTA.

BY WARREN UPHAM.

Typical Potsdam quartzyte outcrops one mile southeast of Dell Rapids (which is on the Sioux river, some fourteen miles west from the northwest corner of Rock county), dipping about 2° south, 35° west (as referred to the true meridian). *Glacial striæ*, well shown at this place, bear south 25° to 30° east. (This locality, like the mound, is beyond the limits of the ice of the last glacial epoch, and therefore these striæ were formed by the earlier ice-sheet. When that ice-sheet terminated beyond the Missouri river in Nebraska and Kansas, we cannot doubt that the ice current moved nearly from north to south upon all this region midway between the west border of the ice and the driftless, never ice covered, area of Wisconsin and southeastern Minnesota; but the prevailing striation at the mound and the pipestone quarry bearing southwesterly, and of this locality near Dell Rapids bearing southeasterly, demonstrate that during the final melting and recession of that earlier ice-sheet it became in this portion lobed, with different slopes of its surface and different directions of the motion of its ditsinct lobes and their various portions, principally (as I believe) produced by meteorological conditions, nearly as the terminal moraines of the last ice-sheet show that it, in the later glacial epoch, was lobed and had different directions of motion in its different parts upon areas not more than twenty-five miles distant from these localities toward the northeast and northwest. (See plate VI, in the *Ninth annual report*). *Ripple-marks* are occasionally seen on the quartzyte at this outcrop. This rock is here visible in low exposures, extending an eighth of a mile, along a northwardly sloping slight depression excavated by drainage.

Quartzyte also outcrops one mile due east of Dell Rapids, on the east side of the Big Sioux river (commonly called simply "Sioux river"); and again, one and a half miles north of Dell Rapids, on section three, about one and a half miles west of the river. These are its most northern exposures that I heard of in this region. No fossils, no pipestone, and no conglomerate portions, are known in this quartzyte.

Water power. William Van Eps, Dell Rapids (s. ½ of sec. 9); Dell Rapids mills; fall, eleven feet, with right to increase to fourteen. The fall in the Sioux river, at and below Dell Rapids, from Van Eps' pond (which holds the river as back-water to a distance of three miles), to a point one and a half miles south of the junction of the "Dells" channel, or about four miles south of Dell Rapids village, is approximately twenty-five feet. At Mr. Van Eps' present hight of flowage, a dam about three feet high has to be provided to turn the water of this pond in the Sioux river from running into the "Dells" channel; but before the mill dam was built the stage of low water at the bridge at Dell Rapids was about six feet lower than the divide between it and the "Dells." This sketch, figure eight (I have no good map), will serve to give some idea of the relative position of the localities mentioned.

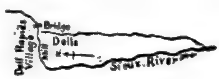

FIG. 8.

"*The Dells.*" The Sioux river, after passing the village of Dell Rapids, first runs westerly a half mile, more or less, and then flows south, inclosed by walls of Potsdam quartzyte. Another rock-walled channel of the same kind, called the "Dells," already several times referred to, extends south from near the bridge in Dell Rapids village. It is thus east of the present course of the Sioux river at its ordinary stage, but a large part of the river flows through this channel at its times of flood. The picturesque rock gorge called the "Dells" extends about one and a half miles in rock, from near the river at Dell Rapids village to the south; and this channel is said to continue across the alluvial bottom-land about one and a half miles further before joining the present channel of the Sioux river. The highest walls of this gorge are within three-quarters of a mile south of Dell Rapids, along which distance they rise vertically on each side 30 to 40 or 50 feet above the still water that fills the bottom of the gorge along a distance of one and a quarter miles, varying in width from three to five rods, and ten to twelve feet deep. The rock here is typical quartzyte, dipping two or three feet in a hundred, or

about one degree, to the south-southwest. This quartzyte is bedded in layers from a few inches to one foot or rarely two feet thick, and is intersected by very numerous vertical or nearly vertical joints, which often divide it into rhomboidal fragments only from three to six inches or a foot long. The surface of the bedding-planes is frequently ripple-marked. No glacial striæ were found here; all the rock surface appears somewhat water-worn. The erosion of this channel has been facilitated by the jointed structure of the rock, and both this and the channel now occupied by the river have probably been eroded by this stream since the ice age.

This quartzyte is mostly very hard and of a reddish gray color, about as at its exposures near New Ulm, in Cottonwood county, and in Pipestone and Rock counties. At the quarry on the east side of the "Dells," near their south end, a mile south of Dell Rapids village, the color of this stone is light gray, slightly tinged toward pink. Rarely it occurs with a quite soft, somewhat friable texture, as was found in a well at Dell Rapids. This rock is seen in frequent low outcrops for about a mile south from the south end of the "Dells," beyond which no rock-outcrops were learned of in the next fifteen miles southward, their next occurrence being at Sioux Falls.

The gorge through which the Sioux river flows, close below Mr. Van Eps' mill, or about a mile southwest from Dell Rapids village, is said to be inclosed by vertical walls of the quartzyte, some fifteen feet high. In this channel three remnants of the rock stand up like bridge piers, having the same hight as the rock on each side. The whole thickness of the Potsdam quartzyte exposed at Dell Rapids is about seventy-five feet; it cannot exceed one hundred feet. Its top here may be one hundred feet above its top at Sioux Falls; this estimate being dependent mainly on another, namely, that the river at Dell Rapids is seventy-five feet above Emerson, Sherman & Co's mill pond at Sioux Falls.

Bottomland from one to two miles wide borders the Sioux river from a point one and a half miles south of Dell Rapids to Sioux Falls. Its hight is about ten feet above the river, by which it has been overflowed three times during the past eleven years. The surface at each side is moderately undulating till, with swells 25 to 40 feet above its depressions, the hight being 50 to 90 feet above the river and the bottomland.

Nils B. Peterson's well; northwest quarter, Section 3, T. 102, R. 49 (nine miles north of Sioux Falls), well, 30 feet; soil, 2; yellow

till, spaded, 5 feet; sand, 3 feet, yielding the only water found; very hard blue till, picked, 21 feet, and extending lower; water a plenty for house and twenty cattle. The till here and generally in this region, contains as large a proportion of gravel and boulders (varying in size from a few inches or one foot to five feet in diameter) as is usually found in the till of southern and western Minnesota.

Pipestone, similar to that of the famous pipestone quarry in Minnesota, is reported as occurring eight miles distant, nearly due west from Mr. Peterson's (therefore about 12 miles northwest from Sioux Falls), or four miles west of New Hope post office, on Skunk creek in the northeast part of T. 102, R. 51. Much of this pipestone is red, other portions are mottled or sometimes nearly cream-colored, as at the Indian pipestone quarry. It has been whittled into pipe bowls and various trinkets. It is hard at the surface, but softer within; and is thought to form a layer four feet or more in thickness, inclosed in the quartzyte. It has been used to build chimneys, where it does not crack and crumble like the quartzyte.

Sioux Falls. The Potsdam quartzyte is next found exposed in low outcrops about two miles west of Sioux Falls, on the broad bottomland of the Sioux river. The valley eroded in the thick sheet of glacial drift by this river below (eastward from) Sioux Falls is about a mile wide and inclosed by bluffs 100 feet or more in hight on its north side, and from 125 to 150 feet (probably nearly 200 feet at three miles east of Sioux Falls) in hight on its south side; these bluffs being steep, with more knolls, buttresses and ravines than usual (as, for example, on the Minnesota river), making a quite picturesque view as seen from a point a mile north of Sioux Falls, looking eastward and southward. This valley is eroded through till, which in some places was seen to be thinly covered by loess, nearly as in southwestern Rock county, and elsewhere, more rarely, by deposits of gravel and sand; the quartzyte of this vicinity is exposed only in the bottom of the valley, and ends in low outcrops about a half mile below (north and northeast of) Sioux Falls.

Mr. William Van Eps, of Sioux Falls (owner of mill at Dell Rapids), reports outcrops of quartzyte (nearly like that at Sioux Falls) on the James river at Rockport in Hanson county and again in the same county seven miles further north (a few miles below Firesteel, a place formerly important but whose glory has de-

FIG. 9.

parted, eclipsed by Mitchell, three miles distant to the west;) but he thinks this rock has no other exposures on the James river. About fifteen miles east of Mitchell, good quartzyte for quarrying occurs on Pier creek, where it is crossed by the railroad and further north. I think that this quartzyte is reported by Hayden on the east and west Vermilion rivers, in McCook county.

Water power at Sioux Falls. Three dams and mills are here located on the Sioux river:

1. Cascade mills; the upper mill, Emerson, Sherman & Co.: fall or head, 10 feet, flowing the river back about two miles.

2. Queen Bee mill; Sioux Falls Water Power company: head, 56 feet; this mill (built, if I rightly remember, of the quartzyte of this vicinity) is 80x100 feet in dimension, and seven stories (106 feet) high; its walls are 5 feet 4 inches thick at the base, and 2 feet 6 inches at the top.

3. Sioux Falls mills; the lower mill; Webber, Shaw & Watson: head, 14 feet. This lowest mill is not more than a half mile below (north of) the upper mill. There may be five feet of fall lost between these mills; but I think less, or none. The total fall within the city limits (section 16) is said to be 85 feet, which must be nearly or quite correct. If a canal were cut across the base of the river's extensive circuit west of Sioux Falls, excavating about ten feet deep across bottom land for a mile, and some 30 feet in depth for a quarter of a mile through the ridge of drift which extends southward in the west edge of the city, it is said that a fall of about 110 feet in total, or 25 feet more than now, would be obtained.

The rock of Sioux Falls is the typical Potsdam quartzyte, similar in texture, hardness, color (usually reddish-gray), bedding (frequently ripple-marked), and joints, with its outcrops in Nicollet, Cottonwood, Pipestone and Rock counties, and at Dell Rapids. Its dip varies from a half degree to two or three degrees, or a descent varying from one to five feet in a hundred, toward the south and south southwest. Allowing for its dip, the whole thickness of this rock exposed at Sioux Falls is approximately 125 feet; it cannot exceed 150; it nowhere rises much (not more than 20 or 30 feet) above the river at the head of the falls.

Quarries of this stone have been worked in small amount two miles west of Sioux Falls; two miles south of this city on the left (there north) side of the Sioux river, about a half mile from

it, this quarry yielding good stone; and, most of all, in the north part of Sioux Falls corporation. Hayden (in the *Am. Jour. of Sci. and Arts*, for Jan., 1867) says, in describing this formation at Sioux Falls: "About ten feet from the top of the rocks as seen at this locality, is a layer of steatitic material, mottled, gray and cream color, very soft, about 12 inches thick, which is used sometimes for the manufacture of pipes and other Indian ornaments. * * * There are also beds of pudding stone, and the most beautiful illustrations of wave and ripple markings that I have ever observed in my geological explorations."

Glacial striæ. The surface of nearly all the quartzyte exposed at Sioux Falls is so waterworn that its glacial marks have been effaced. Considerable search afforded me only the following observations: About 20 to 25 rods north of the St. Paul & Sioux City (C., St. P., M. & O.) railroad depot, glacial striæ, seen in a half dozen or more places, mostly bear uniformly S. 40° E. (referred to the true meridian, allowing 10° for the needle's variation east of north); but on one surface here, six feet square, situated 10 to 50 feet distant from foregoing glaciated places, are very clear glacial striæ, bearing due east. About a dozen rods northeast from these, striæ were again found, on a smooth surface of rock about ten feet in extent, where they vary in their direction from due south to S. 25° E., these courses being seen on the same surface crossing each other. For the reasons set forth on pages 505 and 549, of vol. 1, final report, it is probable that the striæ bearing south are the oldest, and that the striæ bearing southeasterly and east are records of a progressive deflection here of the ice-current toward the east, by the formation of a lobe in the ice-sheet of this first glacial epoch during its recession. How this would take place will be understood by referring to Plate VI, in the *Ninth annual report.*

Terraces. During the river's excavation of its valley in the thick drift-sheet along the first six miles east of Sioux Falls, a well-marked terrace-plane was formed 60 to 75 feet above the present channel, portions of which remain as follows: One, about two miles long and 20 to 40 rods wide, on the northwest side of the river, 2 to 4 miles northeast from Sioux Falls; another, one and a half miles long and 30 to 60 rods wide, situated on the south side of the river, about 3½ to 5 miles northeast of Sioux Falls; and a third, or perhaps several, seen in the view down the valley within a few miles further southeastward. The first of these terraces, and probably the others, consists of till,

with frequent boulders on its escarpment or face, and in some places on its flat surface above; but mostly this upper surface is thinly covered with fluvial deposits of gravel and sand.

Contour. Lakes and sloughs are rare or absent in all this region; I saw none. The surface is very smooth till, seldom having any covering of loess. The contour of this drift-sheet is quite different from that found upon the regions that were overspread by the last ice-sheet; but closely resembles that of Pipestone and Rock counties. It is characterized by massive swells of varying hight, tending mostly from north to south, or more so than in other directions. The separate swells are usually from 25 to 50 feet above the intervening hollows or depressions; while areas a few miles apart vary sometimes 100 or 150 feet in their average hight. No drift deposits marked by the peculiarly rough and broken contour of our terminal and medial moraines were found in this region.

Palisades post-office, store, and mill are in sections 30 and 31, T. 103, R. 47, at the middle of the south side of section 30, about four miles west from the state line of Minnesota. The

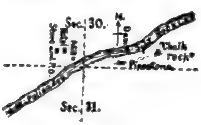

FIGURE 10.

"palisades" extend from the dam a half mile southwestward, the Split Rock creek being confined along this distance between vertical walls of the Potsdam quartzyte, 40 to 60 feet high, and from 50 to 150 feet apart. A "rock island" rises like a tower in the middle of this gorge, about 20 rods south of the mill, and 60 feet high, its top being seen with that of the walls at each side, which here attain their greatest altitude.

Palisades mill, C. W. Patten; fall, 23 feet; cable to mill, 212 feet; hight from stream below the wheel to the mill, 55 feet. Split Rock creek is said to descend 72 feet in its four miles next above the southwest (lower) end of the Palisades.

The rock here is the typical red Potsdam quartzyte, dipping two to three degrees, or about four to six feet in a hundred, to the south-southwest. This formation embraces in this vicinity two layers, each several feet thick, of compact, fine-grained, red rock, easily cut and polished, closely resembling the catlinite of the Pipestone quarry in Minnesota. The upper one of these layers is seen a quarter of a mile southwest from the mill on the northwest side of the creek, where it has been quarried and is called "slate." Its vertical exposure in the quarry is seven feet, but its base, though probably not much deeper, is not seen.

It lies in sheets from an eighth of an inch to six inches thick, dipping about two degrees S. 30° W. The plane of this bed, prolonged northeastward, passes just above the top of the Palisades. The lower one of the two layers mentioned is called "pipestone," and is scarcely inferior in quality to that of the Indian quarry in Pipestone county. This bed is exposed about five rods south of the dam and some thirty rods east of the mill, where it is seen to have a thickness of at least four feet (it may be as much as seven feet thick) divided in sheets, from a half inch to three or four inches thick. It here dips 6° or 7°, or ten or twelve feet in a hundred, S. 60° W. The unusual steepness of this dip, as compared with the average and nearly uniform dip of the whole formation in this locality, is doubtless due to a local displacement of very small extent; for the floor of quartzyte, on which this pipestone lies, varies in its inclination, within three or four rods away from this bed, to the average dip of about two degrees. At the bottom of the wheel-pit of the mill, 30 rods west from this pipestone quarry, the top of this pipestone layer, having the same fine quality, was excavated to a depth of six inches. The top of this layer in the wheel-pit was 12 or 14 feet lower than its base at its exposure near the dam. This pipestone layer is thus contained in the quartzyte very nearly at the water-line of the creek in the Palisades, being 60 feet, approximately, lower than the similar bed called "slate."

Twenty rods east of the dam at the Palisades, and about 20 to 25 feet above this dam, is an excavation (made to get material for building the dam) into "chalk rock," which is thus exposed with a vertical thickness of four feet (though its base is not seen) and along an extent of about 50 feet, dipping the same as the quartzyte, about two degrees, or some four feet in a hundred, to the south-southwest. It occurs in sheets or layers, which vary from a quarter of an inch to two inches in thickness; and these are much traversed by joints, whereby this rock is divided into a multitude of small rhomboidal pieces, usually a few inches (seldom a foot) long. The upper part of this bed is soft, being scarcely harder than many shale beds, and is whitish, often quite white; it gradually changes below to a pinkish color, and at the same time becomes harder and exhibits fewer joints in its lower portion. In fineness and microscopic homogeneity of texture, it is closely like pipestone (catlinite), which it also probably resembles in chemical character (see Prof. Dodge's analysis, p. 203, *Tenth an. rep.*), not being calcareous, so that its

name, applied by Mr. Patten, is a misnomer. This "chalk-rock" is not seen in contact with the quartzyte or other bedded rocks; but its conformity in dip with the Potsdam formation, so extensively exposed in its immediate vicinity, makes it highly probable that it is a layer inclosed in the quartzyte. It lies in the line of continuation of the closely contiguous "pipestone," and may be only a changed portion of that bed, perhaps having come into its present condition by weathering. If this "chalk-rock" is ground to powder and then wetted, it dries in a hard mass, having about the same hardness as in its original bed.

The following is reported by Mr. C. W. Patten, of the Palisades: About six miles south of this place, or four or five miles above (N. N. E. of), the mouth of Split Rock creek, rock [Cretaceous?] in many respects similar to this "chalk-rock," perhaps harder, all of it whitish as the "chalk" is only at its top, occurs in thicker and more compact layers, and has been considerably used for building. It is cut into dimensions by a common saw; and in weight it is much lighter than the "chalk-rock" of the Palisades, so that a cord of it can be drawn by two horses. It forms a stratum at least eight feet thick, and is in layers from 4 to 8 or 10 inches thick; it is divided by joints with about the frequency desirable for convenience in quarrying. Its exposures (it is thought that the red Potsdam quartzyte is not seen in that vicinity), are between 5 and 20 feet above the Split Rock creek; and it is quarried at two places, or more, partly upon each side of the creek, which there is probably 75 feet lower than at the Palisades.

No such rock, nor anything comparable with it, is found associated with the Potsdam quartzyte, either in Dakota or Minnesota, north and northeast of the Palisades. No fossils have been seen in the "chalk-rock," nor in any portion of the Potsdam formation, at the Palisades, by Mr. Patten, who has excavated several hundred loads of the "chalk" for his dam. Excepting the beds thus called "slate," "pipestone" and "chalk-rock," the two former of which are clearly seen to be layers in the Potsdam formation, all the extensive exposures of its beds at the Palisades are the ordinary quartzyte, having its usual characters in respect to color, hardness, bedding and joints. No conglomerate was observed here; ripple-marks were seen on the bedding-planes in a few places. Rarely this stone, probably through the influence of weathering (perhaps in preglacial ages), has a soft and somewhat friable structure; this has been noticed

by Mr. Patten in some outcrops within a quarter of a mile from the Palisades; and four miles to the northeast a somewhat soft, pinkish sandstone (probably an altered form of this quartzyte) has been encountered in digging wells. The next exposures of the Potsdam quartzyte south of the Palisades are reported to be nine or ten miles distant, at the east side of the Sioux river, on the upland. Only a few miles further south, this quartzyte outcrops in the extreme northwest corner of Iowa.

The "Devils Gulch" is two and a half miles north-northeast from the Palisades and is a similar canon-like gorge, a half mile long, at the east side of Split Rock creek, on a trifling tributary. Its walls of rock are vertical, 30 to 50 feet high, and from 8 to 75 feet apart, with pools of water ten feet deep in the bottom of the gulch. The rock here is typical Potsdam quartzyte, dipping two and a half or three degrees (four to five feet in a hundred) towards the south-southeast, or, more exactly, S. 30° E. Here some parts of the walls, as also at Dell Rapids and the Palisades, are so intersected by vertical joints, nearly at right angles and from six inches to two feet apart, that the wall resembles ancient masonry, the separate rocks being rounded at the edge by weathering. It is also not uncommon to find places at the surface of this rock, where it similarly resembles the square paving blocks of stone sometimes used for streets. The Palisades and this Gulch seem to me equal in picturesqueness; both being worth going far to see, especially in this region of infrequent rock exposures.

No glacial striæ were observed at the Gulch nor at the Palisades.

XIII.

CHEMISTRY.

REPORT OF PROFESSOR DODGE.

THE UNIVERSITY OF MINNESOTA,
CHEMICAL LABORATORY.
MINNEAPOLIS, MINN., Oct. 6, 1884.

Professor N. H. Winchell,

DEAR SIR: I herewith report to you the results of the analyses made by the chemical department for the state geological survey since my last report. The present report comprises the analyses of nineteen siliceous rocks, numbered in the chemical series from 148 to 166 inclusive; also the analysis of a sample of impure graphite, and the analyses of two samples of water.

These analyses have been made almost wholly by Mr. C. F. Sidener, now instructor in the chemical department.

Very respectfully yours,
JAMES A. DODGE,
Prof. of Chemistry.

Chemical series No. 147. The water of Big Stone lake. The composition of the mineral matter dissolved in this water has been found to be as follows:

	Parts per million.	Grains per gallon.
Silica	106.50	6.2090
Carbonate of iron	2.20	.1283
Calcium carbonate	110.50	6.4455
Magnesium carbonate	63.00	3.6748
Magnesium sulphate	148.05	8.6358
Potassium sulphate	12.48	.7280
Sodium sulphate	95.63	5.5781
Sodium chloride	15.12	.8819
Phosphates	traces	
	553.48	32.2814

The amount of organic matter was such as to require 1.32 parts of oxygen per million parts of water for its oxidation. Yet this amount is not very excessive, being rather less than that in the Mississippi river just above this city.

The water is remarkable for the large amount of sulphates; also for a rather large proportion of silica.

RESULTS OF CHEMICAL ANALYSES OF SILICEOUS ROCKS.

CHEMICAL SERIES NOS. 148–166.

	Chemical series No. 148.	Chemical series No. 149.	Chemical series No. 150.	Chemical series No. 151.	Chemical series No. 152.	Chemical series No. 153.	Chemical series No. 154.	Chemical series No. 155.	Chemical series No. 156.	Chemical series No. 157.	Chemical series No. 158.	Chemical series No. 159.	Chemical series No. 160.	Chemical series No. 161.	Chemical series No. 162.	Chemical series No. 163.	Chemical series No. 164.	Chemical series No. 165.	Chemical series No. 166.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Silica, SiO_2	66.36	53.71	57.50	48.81	73.72	65.56	52.54	71.15	71.99	73.28	76.68	69.66	66.72	50.31	7[illegible].58	81.86	73.91	75.19	48.92
Alumina, Al_2O_3	13.33	14.96	13.29	23.27	12.82	10.06	13.50	12.40	12.36	11.83	12.14	11.49	7.41	14.17	13.36	9.87	14.89	10.78	18.45
Sesquioxide of iron, Fe_2O_3	7.89	14.45	11.62	11.80	2.51	14.40	15.35	5.21	4.99	4.61	3.16	3.95	10.13	10.96	3.78	1.44	2.27	4.01	16.88
Protoxide of iron, FeO	2.96	3.65	4.54	3.66	0.22	0.23	3.60	0.75	0.56	0.56	0.52	0.60	0.69	1.09	0.69	2.36	1.70	1.05	0.57
Lime, CaO	2.14	3.35	6.12	5.15	1.70	0.96	6.51	1.90	0.85	1.04	0.25	2.64	3.10	8.44	0.81	0.46	0.27	2.36	0.70
Magnesia, MgO	1.20	4.59	1.63	1.72	0.35	0.73	3.73	1.13	0.72	0.36	0.26	0.71	4.06	5.86	0.18	0.81	trace	0.95	3.68
Potash, K_2O	3.05	0.56	0.80	0.75	2.40	2.88	0.37	2.40	2.45	4.50	3.53	1.08	0.42	0.46	2.48	0.45	2.78	0.93	1.32
Soda, Na_2O	2.63	1.40	1.85	2.38	2.70	2.25	1.10	1.70	0.99	1.66	1.06	1.15	0.86	0.90	2.42	1.61	2.64	1.93	0.48
Water, H_2O	1.21	1.60	1.48	2.53	0.94	0.86	3.34	2.12	2.92	1.82	1.66	8.55	5.32	7.63	1.14	1.43	1.01	1.42	7.14
	100.77	98.27	98.83	100.07	97.36	97.93	100.04	98.81	97.83	99.66	99.26	99.83	98.71	99.72	98.44	100.29	99.47	98.62	98.14

Chem. series No. 167. Sample of impure graphite, from near Aitkin.

Carbon (graphite)	41.28	per cent.
Silica, SiO_2	43.23	"
Oxide of iron, Fl_2O_3	2.02	"
Alumina, Al_2O_3	10.70	"
Lime, CaO	0.46	"
Magnesia, MgO	0.05	"
Undetermined matter	2.26	"
	100.00	

Chem. series Nos. 168 *and* 169. Brine from the Humboldt salt well.

Ingredients dissolved in the water.	Parts per million.	Grains per gallon, U. S.
Silica, SiO_2	208.5	12.15
Alumina, Al_2O_3	40.9	2.38
Carbonate of iron, $FeCo_3$	18.56	1.08
Sulphate of lime, $CaSo_4$	1,990.2	116.08
Sulphate of magnesia, $MgSo_4$	1,236.4	71.12
Carbonate of magnesia, $MgCo_3$	1,347.5	78.60
Chloride of magnesium, $MgCl_2$	1,567.6	91.44
Chloride of calcium, $CaCl_2$	2,684.0	156.55
Chloride of potassium, KCl	724.3	42.26
Chloride of sodium, NaCl	47,402.5	2,764.99
Phosphoric acid	traces.	....
Total solids	57,220.46	3,336.65

Proportion of common salt, NaCl, in the total dissolved solids, 82.8 per cent. The samples from the depths of 180 feet and 450 feet were united, and the analysis above expresses the composition of the brine thus obtained. That from the depth of 450 feet was apparently some stronger in sodium chloride than that from 180 feet.

Chem. series, No. 170. Analysis of water of the Mississippi river taken at Brainerd:

Ingredients dissolved in the water.	Parts per million.	Grains per gallon U.S.
Silica, SiO_2	18.2	1.0616
Alumina, Al_2O_3	3.9	0.2275
Carbonate of iron, $FeCo_3$	4.205	0.2453
Carbonate of lime, $CaCo_3$	111.07	6.4787
Carbonate of magnesia, $MgCo_3$	27.72	1.6169
Carbonate of potash, K_2Co_3	6.0	0.3499
Carbonate of soda, Na_2Co_3	19.36	1.1292
Sulphate of soda, Na_2So_4	3.0	0.1749
Chloride of sodium, NaCl	1.5	0.0875
Nitrates	traces	traces
Phosphates	slight traces	slight traces
Total solids	194.955	11.3715

	Parts per million
Oxygen required for the oxidation of organic matter by the permanganate test	1.28

Chem. series, No. 171. Assay of a sample of ore for gold and silver.

Results: Gold none; silver none.

Chem. series, No. 172. Assay of a sample of ore for gold and silver.

Results: Gold none; silver $5\frac{4}{10}$ Troy ounces per ton of ore.

Chem. series No. 173. Supposed fossil shells in catlinite. (See before, page 103.)

NOTE.— The foregoing substances were derived as follows:

No. 147. Water from Big Stone lake, obtained by C. L. Herrick.

No. 148. Geol. survey number 1 B.; finely crystalline red syenite. Duluth.

No. 149. Geol. survey number 7; finely crystalline brown syenite. Duluth.

No. 150. Geol. survey number 19; crypto-crystalline, or amorphous, yet sparsely porphyritic with red feldspar and slightly amygdoloidal with epidote. Duluth.

No. 151. Geol. survey number 46; fine dark rock, thickly porphyritic with red feldspar, from Brewery creek. Duluth.

No. 152. Geol. survey number 68; "streamed," light red, metamorphic rock, with translucent laminations and specks. From near London.

No. 153. Geol. survey number 74; brick-red, rather fragile, apparently gritty and subcrystalline. At the mouth of Passabika river.

No. 154. Geol. survey number 117; "Two Harbor rock," crypto-crystalline, brown, conchoidal fracture, heavy.

No. 155. Geol. survey number 124; purplish red granite, from the west bluff at the entrance of Beaver bay.

No. 156. Geol. survey number 127; gray quartzyte, mouth of Beaver creek, Beaver bay.

No. 157. Geol. survey number 134; red granite, from the third island below Beaver bay.

No. 158. Geol. survey number 139; rock of the bulk of the Great Palisades.

No. 159. Geol. survey number 140; red, laminated, or "streamed," at the base of the Great Palisades.

No. 160. Geol. survey number 149; red, shaly, sandrock, associated with conglomerate, half a mile below the first falls of Baptism river.

No. 161. Geol. survey number 161, A; brown, aluminous vein-rock, crystalline (?), from trap-rocks at the town line between ranges 5 and 6 (on sec. 36), east of Pork bay.

No. 162. Geol. survey number 203; the red rock at Grand Marais, furnishing the pebbles of the beach.

No. 163. Geol. survey number 262; slaty, pinkish quartzyte, at the head of Wauswaugoning bay.

No. 164. Geol. survey number 285; red granite, from the first island N. W. from Belle Rose island, south of Pigeon point.

No. 165. Geol. survey number 555; red sandstone or quartzyte, fine grained, from the north side of Siskiwit point, Isle Royale, formerly quarried for building stone.

No. 166. Geol. survey number 809; red shale, from the quarry at Fond du Lac, resembling the pipestone of southwestern Minnesota, but softer and more sectile.

No. 167. Graphite from the vicinity of Aitkin, from Mr. —— Palmer, said to be from a well which struck the rock at 18 feet, situated two miles N. W. from Aitkin, apparently in a bed in the rock of the region.

No. 168. Brine from the Humboldt well, in Kittson county, from the depth of about 180 feet; artesian.

No. 169. Brine flowing from the large pipe at the Humboldt well, from the sandrock at the depth of 450-500 feet.

No. 170. Water from the Mississippi river at Brainerd, obtained by Dr. Howe in August.

No. 171. Iron ore, from Mayhew lake, north of Grand Marais.

No. 172. Rotted trap-rock, from T. 64.7 W., sec. 23, supposed to contain gold. From E. M. Fowler.

No. 173. Small slab of pipestone, Museum register number, 5,559; to scrape off the supposed fossil shells and test for phosphorus or lime.

N. H. WINCHELL.

XIV.

MINNESOTA GEOGRAPHICAL NAMES DERIVED FROM THE DAKOTA LANGUAGE, WITH SOME THAT ARE OBSOLETE.

BY PROF. A. W. WILLIAMSON.

[NOTE.—Pronunciation is indicated by respelling the word in a phonetic alphabet identical with that of Dr. Riggs' dictionary, except that the digraphs ch, gh, kh, sh, and zh, are used for his dotted c, g, k, s, and z, and only one form of n. A as in far; e as a in fate; i as in machine; o as in note; u as in rule; ch as in charm; kh as German ch; gh subvocal of kh, *i. e.*, continuant of g; zh as z in azure; t, k, p, w, h, s, and z as in English; b and m nearly as in English, but made nearer together; n and d approach each other still more, it being difficult for an unpracticed ear hearing some words spoken by some Indians to determine which of the two is used; n when it ends a syllable is sounded as Canadian *voyageurs* sound n in bon, much more strongly than the same sound is given by Parisians. Most Dakotas very slightly nasalize all their vowels, and in the case of a succeeded by k this nasalization is quite perceptible to a practiced ear; as, however, it is an entirely different sound from the nasal represented by n, it is obviously improper to confuse words by representing it in the same way, and being an accidental sound of no etymological value and scarcely perceptible in pronunciation, it does not seem desirable to represent it at all. That we should write Makato instead of Mankato is evident in this, that *maka* means earth and *manka* skunk, and no Dakota in saying blue earth would in any case use the strong nasal sound represented by n, and which if used would lead the hearers to suppose he meant, blue skunk. It is said that Fremont (Nicollet's map) wrote Mahkato and the h was changed to n by a broken type.]

Anoka (anoka),—on both sides; name applied by founders to the city laid out on both sides of Rum River, and since applied to the county.

Chaska (chaske),—first born child if a son; applied to the village by its founders.

Chapah (chapa),—beaver; the Dakota name of Beaver creek, a tributary of the Minnesota, and still retained on old maps.

Chanka sndatatah (chanka sdata),—*chan*, wood; ka, kindle;

sdata, feeble; the name applied to the Big Sioux river on Nicollet's map, as given by the Dakotas, but I think not in use of recent years. The Dakotas still call the Firesteel, a tributary of the James, or Dakota, Chanka.

Chanshayapi;—*chan*, wood; *sha*, red; ayapi, are on; Redwood river; so called by the Dakotas on account of the abundance of a straight slender bush with red bark, which they scraped off and smoked, usually mixed with tobacco. This name is spelled by Nicollet Tchanshayapi.

Chetanba wakpa (chetanbe wakpa),—*chetan*, hawk; *be*, nest; *wakpa*, river or creek; Hawk creek, a tributary on the north side of the upper Minnesota.

Cokato (chokata),— choka, the middle; ata, at; the name of a station on the Manitoba Railway.

Chokio (chokaya),— the middle; the name of a station on the H. &. D. Ry.

Dakota (dakota),—alliance league; the name by which the Dakotas called themselves; now applied to the territory, to a county, and to a village in Minnesota, etc. Lakota, a village in North Dakota, is the same word in the Titon form.

Eyota (iyotan),—greatest, most; name of a town in Olmsted county.

Hoghanwanke kin,—*hoghan*, fish; *wanke*, lies; *kin*, the; the place where the fish lies, the Dakota name of the St. Croix. For legend see Neil's *Minnesota*, p. 94.

Hokah (hutkan),—root; the Dakota name of Root river, retained on old maps, and now the name of a village in Houston county.

Imnizha ska,—*imnizha*, ledge; *ska*, white; the Dakota name of St. Paul, given on account of the white sandstone cropping out in the bluffs.

Intpah (intpa or inkpa,—k and t interchangeable before p),—end; the Dakota name of Lac qui Parle creek, flowing into the river at the end of the lake.

Inyan tankinyanyan,—*inyan*, stone; *tankinyanyan*, big; the Dakota name of Big Stone lake. The name is translated on Nicollet's and other old maps. It is so named on account of the large number of drift boulders along its shores.

Inyan sha,—*inyan*, stone; *sha*, red; the Dakota name of *Red Rock*, near St. Paul. A few rods from the river, near the house of Mr. Ford, an early settler, was a large egg-shaped syenite boulder, believed by the Indians to be the abode of a powerful

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spirit, which they worshiped by keeping the stone carefully painted red, and by offerings of food. Every stone and every other natural object was believed by the Dakotas to be the abode of a spirit, but hard, egg-shaped stones only were worshiped.

Ipakshan,—crooked; *Mdeipakshan*, crooked lake, another name given to Big Stone lake, referring to its shape; *wakpa ipakshan*, crooked river; the Dakota name of the Big Sioux river.

Isantamde, knife lake; one of the Mille Lacs, found with variant spellings in the Dakota form, and translated, on old maps.

Isanti (isanati or isanyati),—*isan*, knife; *ati* dwell on or at; the Dakota name of the part of the nation occupying Minnesota, and comprising the Sissetons as well as those now known as Santees; it is supposed the name was given as this lake was their chief location for a time on their westward journey; the name of a county.

Ishtakhba,—*ishta*, eye, *khba*, sleepy; the name of an eminent Dakota chief, a firm friend to the whites, who was the first signer of the treaty of 1851. The name was probably applied to Sleepy Eye lake about 50 years ago, when his band planted there. Nicollet's map names it Sleepy Eye lake; it is now also the name of the village near it.

Iyedan (iyedan),—*mde*, lake; *iye*, speaks; *dan*, diminutive suffix, forms mdeiyedan, the Dakota name of Lac qui Parle, given as *iyedan* lake on old maps; it is very uncertain how it received the name; one tradition says from an echo on its shores; but it is doubtful if any such existed; another tradition is that when the Dakotas first came to the lake voices were heard, but they found no speakers; some think the word has changed its form.

Iyakhba,—sleepy ones; the name of the Iowa Indians and the country occupied by them. Early explorers state that this is the Sioux (Dakota) name. It is probable that 200 years ago the Santees pronounced this word as the Titons now pronounce it, Iyakhwa. As the kh is a sound not found in French it was often omitted, and usually expressed by h, if at all, which occasionally occurs. The spelling *Ayavois*, as given by Le Sueur, is as near to this word as could be expected.

Izuza (izuza),—whetstone; the Dakota name of Whetstone creek, a tributary of the Upper Minnesota; the Dakota form is retained on Nicollet's map.

Khakha,—falls; the Dakota name of St. Anthony's Falls, as pre-eminently *the falls*.

Khakha wakpa,—falls river; the Dakota name of the Mississippi river.

Kandiyohi (kandiyohi),—*kandi*, buffalo fish; *y*, euphonic; *ohi*, arrive in; name of the lake which still retains it, since given to the town and county.

Kanpeshka (kanpe ska),—name of a round, curved, white medal, made of shell and worn by the Dakotas, and probably given to the lake a little west of the boundary on account of suitable shells for making these ornaments which were found there.

Kaposia (kapozha, the *p* written by Dr. Riggs with a dot subscript to denote a peculiar palated modification),—light; the name of Little Crow's band, and the site of their village four miles below St. Paul on the opposite side of the river. The name was given in honor of their skill in the favorite game of *lacrosse*, in which one band played against one, or sometimes against two others, for large stakes. Success depended largely on swiftness (lightness).

Kasota (kasota),—clear or cleared off; the name sometimes applied by the Dakotas to the naked ridge or prairie plateau south of the village of that name, and now applied also to a creek running through it.

Mahtomedi (matomde),—*mato*, the gray bear, *ursus maritimus*, *mde* lake; the Dakota name of White Bear lake, now the name of a camp situated on it*.

Mahtowa: *mato* grizzly bear; *wau*, one; name of a station on Duluth Railway, north of Hinckley.

Mankato (makato),—the Dakota name of Blue Earth river, the name of the city as now spelled would in Dakota mean blue skunk (see remarks on pronunciation, *ante*).

Mayawakan (maya wakan),—*maya*, steep banks; *wakan*, wonderful, sacred, mysterious, here properly translated remarkable; the Dakota name of the Chippewa river, tributary to the Minnesota; the Dakota form is given on many old maps. It is said that *Chippewa* is our translation of the Dakota work Khakhatonwan, dwellers at the falls, *i. e.*, Falls of St. Mary, and that it was applied because the Dakotas sometimes spoke of it as the river down which they came.

Mdewakanton,—dwellers at the lake; a name applied to the part of the Santees occupying eastern Minnesota and western Wisconsin, said to have been given because they still continued for a time on lake Superior after the other Dakotas left it.

* A well-known summer resort, near the village of White Bear lake, near St. Paul.

Mdechan,—*mde* lake; *chan* wood, Wood lake; the Dakota name of the lake where General Sibley gained the decisive victory over the rebel Dakotas, Aug. 23, 1862.

Mdehdakinyan,—lake lying crosswise; the Dakota name of lake Traverse, it lying crosswise to Big Stone lake.

Mde Minnesota (mde minisota),—sky-tinted lake, or having water nearly clear, but with a slight whitish tint; the Dakota name of Clear lake near Fort Ridgely; the Dakota form is given on some old maps.

Mdeyata,—*mde*, lake; *ata*, at; at the lake; this expression was used by the Dakotas in speaking of lake Superior, regarded by them as pre-eminently *the lake*, and so not specially named.

Mde tanka, great lake, signifying the ocean, of which they retained distinct traditions.

Mdeyatanka,—*mde*, lake; *ya*, they speak, say; *tanka*, large; the lake spoken of as large; the Dakota name of Ottertail lake.

Mendota (mdote),—the mouth of a river; name of a village at the junction of the Minnesota and Mississippi. Those living at a distance usually spoke of it as Khakhamdote, junction with the Falls river, *i. e.* the Mississippi river.

Maka re ozey (maka khe oze),—yellow banks; the Dakota name of the Yellow Banks river, a tributary of the upper Minnesota.

Magha tanka,—big goose, *i. e.* swan; the Dakota name of Swan lake, Nicollet county.

Minneapolis,—*mini*, water; *polis*, Greek for city; how the *a* got in seems very uncertain, some regard it as merely euphonic, others as the Dakota prefixed preposition *a*, on, others as an abbreviation of the Dakota *kha*, falls, while still others, but I think with little plausibility, derive it from the Greek.

Minnehaha (minikhakha),—*mini*, water; *kha kha*, falls; khakha is derived from *kha*, curl, being the frequentative form used with *mini*, water, meaning falls; used with *i* mouth, meaning laughing. To translate Minnehaha, "laughing water," though not strictly accurate, is certainly an allowable poetical license; the name of the well known cascade near Fort Snelling; the Dakotas usually called it, chistina, small, in distinction from St. Anthony's falls.

Minneinneopa, or Mineopa, (mini inonpa), *mini*, water *inonpa*, second; the name of a beautiful cascade near Mankato, so called because the second of two falls near together.

Minneiska (mini ska),—*mini*, water; *ska*, white; the Dakota

name of the creek so called; as well said by Rev. A. L. Riggs "the i has no business there," yet it dates back to Nicollet's map.

Minneota (mini ota),—much water, a station on the Winona and St. Peter Railway, said to be so named by an early settler on account of an abundance of water flowing into his well.

Minneola,—*mini* water; *ola*, Latin diminutive, said to have been invented as a parody on Minneapolis, and applied to a township in Goodhue county, as the settlers thought its euphonious sound typical of the beauty of the country.

Mini wakan,—the wonderful water; the Dakota name of Devil's lake, said to have been applied on account of its being so large, and having no outlet. Wakan is persistently translated devil by many frontiersmen, but it is in no case used in that meaning. In names it is nearly always an adjective, meaning wonderful, remarkable; in other cases as an adjective, it means mysterious, sacred; as a noun it always means god.

Minnesota,—(mini sota), water nearly clear but slightly clouded, as that in the Minnesota river, so called by the Dakotas. This river is on old maps called St. Peter's, a name given by the French explorers.

Minnetonka (mini tanka),—great water; the name of the beautiful lake and summer resort near Minneapolis.

Minnewashta,—*minne*, water; *washte*, good; name of a lake known as "White Bear Lake," then "Lake Whipple," and since changed to Minniwashta, by act of the legislature, situated in Pope county, near Glenwood.

Okabena (hokahbena),—*hokah*, heron; *be*, nests; *na*, diminutive suffix; the nesting place of the herons; the name of the lake at Worthington.

Okaman (hokahman),—*hokah*, heron; *man*, nests; the name applied to mills near Lake Elysian, said to have been applied by the Dakotas to the same site. Man and be are variant forms of the same word. The loss of the h in these two words is accounted for by the lighter stress laid on this sound by Dakotas.

Okheyawabe,—*okhe*, hill; *yawabe*, referring to its being much visited; the Dakota name of Pilot Knob, back of Mendota.

Oiyuweghe,—the crossing; the name given by the Dakotas to Travers des Sioux, because they usually crossed the Minnesota here, in going from the upper to the lower villages.

Omaha,—the Dakota name of the Omaha Indians; applied to a small creeek in Southwestern Minnesota, on old maps.

Ojata (ozhate),—forks; the name of a station near Grand Forks.

Owatonna (Owotonna),—straight; the Dakota name of Straight river, on which the city of Owatonna is situated.

Pajutazee (pezhihutazi, abbreviated from Pezhihutazizi ka pi),—*peji*, generic name, including grasses and all other erect plants without wood stems; *huta*, root; *zi*, yellow; *kapi*, they dig; diggings of yellow plant root, or yellow medicine diggings; the Dakota name of the Yellow Medicine river, written by Nicollet Pejuta zizi; the name as first spelled was the name given by Dr. T. S. Williamson to his station, and is found in this form on a number of maps.

Ptansinta,—probably of *ptan*, otter, and *sinte*, tail; the name of the Dakota village at the head of lake Traverse.

Re ipa (khe ipa),—*Khe*, hill or ridge; *i*, prefixed preposition, to; *pa*, head; the Dakota name of the "head of the Coteau."

Remnicha (Khemnichan),—*Khe*, hill; *mni*, contraction of *mini*, water; *chan*, wood; the Dakota name of Red Wing, given on account of the union of these features there; applied also to Hay creek flowing into the Mississippi there.

Sappah (sapa),—black; the Dakota name of Black river, Wisconsin.

Shakopee (shakpi),—six; the Dakota chief of the band formerly occupying the site of this city was *Shakpidan*, Little Six. The usual Dakota name of the band was Tinta tonwan, Dwellers on the prairie.

Shunkasapa,—*shunka*, dog; *sapa*, black; Black Dog, a Dakota chief, and name of his village near Hamilton station, Omaha Railway.

Sisseton (sisin towanyan),—*sissin*, fish scales; *towanyan*, village; the most numerous clan of the Santee Dakotas. They occupied in common with the Wahpetons, nearly all Minnesota west of Carver, except the extreme northern part. The name was given them when they were further east, living principally on fish, and in one village.

Tamaha—pike; the Dakota name of Hudson; for legend see Neil's *Minnesota*, p. 94.

Tanpayukedan—*tanpa*, white birch; *yuke*, is there; *dan*, diminutive; the Dakota name of Birch Cooley, where our forces under Maj. Brown fought a disastrous battle in 1862.

Tchanshayapi, see Chanshayapi.

Tintah (Tinta),—prairie; a station on the Manitoba Railway.

Tintatonwan, see Shakopee.

Tipsinna,—a farinaceous bulbous root, a much used and highly prized article of food; the name applied to the Pomme de Terre, or apple river. The French is a translation from the Dakota, the English a mis-translation from the French.

Wahnatan (waanatan),—he who makes an attack; a celebrated Sisseton chief, formerly the name of a county in Minnesota.

Wabasha (Wapaha sha),—red battle-standard; as *wapaha* is also used to mean hat, this is sometimes incorrectly translated "Red Hat;" the name of the chief whose land occupied the country below lake Pepin and had their village on Winona prairie, which was for many years called "Wabashaw prairie" by steamboatmen and early settlers; it is now the name of a city and county, but the oft repeated statement that this was his residence is erroneous.

Wacouta (wakute),—he shoots; the name of the chief whose band was located at Red Wing; the name of the railway station next south of Red Wing.

Wahpeton (wakhpetonwan), *wakhpe*, leaves; *tonwan*, dwell, dwellers among the leaves, one of the four Santee clans; (see *Sisseton*), a town in Dakota.

Wahpekutey (wakhpekute),—leaf shooters, the smallest of the four Santee clans. They lived chiefly in the valleys of the Blue Earth and Cannon.

Wakinyan oye,—the thunderer's track; given by Nicollet who translated it lightning's track; the name of three small lakes near Big Stone lake. The Dakotas say that these tracks were made by the infant Thunder-god, probably the most worshiped of their deities.

Waraju,—*wagha*, cottonwood; *zhu*, pour, plant, etc.; the name applied by the Dakotas to the Cottonwood and Little Cottonwood rivers on account of the Cottonwood groves so frequent along them. The word *little* is, in Dakota, chistina, and placed after the noun.

Watonwan,—this word might mean "I see," or "he sees," intransitive; it may have been applied to this branch of the Blue Earth as being a prairie country and presenting a good prospect, but it is uncertain whether this is the meaning on which the appellation was given; the Dakota name of the river, now used for the county, also,

Waseca (wasecha),—rich, especially in provisions. I was informed in 1855 by a gentleman who was a stranger to me, who professed to be one of the first settlers, that this name was

given in response to inquiries as to the Indian word for fertile, and adopted as a name. In Dakota writing and books the word *waseca* is spelled as we spell the name, and is a word likely to be given in answer to such a question. The soil is also very fertile. I have since several times seen it stated in print that the word is a corruption of *washichun*, white man, given on account of a solitary white man residing there, but I am unable to ascertain that there was any such resident, or that any Dakota ever gave the place this name, and think the first derivation much more probable. It is the name of a city and county.

Wasioja (wazi ozhu),—*wazi*, pine; *ozhu*, place in, etc.; the Dakota name of the Zumbro river, given on account of the scattered pines; retained on old maps and applied by the whites to a village in Dodge county.

Wastedo,—*washte*, good; *do*, emphatic particle; name of a post office in Goodhue county.

Waubay (wabe),—place of hatching of birds; name of a lake and town west of Millbank, Dakota.

Wayzata (wazi yata),—*wazi*, north (also pine), *ata*, at; the name of the station at the north end of Lake Minnetonka.

Winona (winona'),—first born if a daughter, diminutive of wino woman; the name of the city built on what was formerly called "Wabashaw's prairie." The name of the band was *Kiyuksan*, breakers in two, or violators, so called because they violated the custom forbidding relatives, however distant, to marry.

Yankton (ihanktonwan),—end village; the clan of Dakotas formerly occupying the southeast part of Dakota. It is said that this name was given when their village was at the west end of Lake Superior, but this is uncertain.

In preparing the above I am greatly indebted to an able article in *Iapi Oaye*, January, 1883, by Rev. A. L. Riggs, and to information obtained from my father, Dr. T. S. Williamson.

A. W. W.

XV.

ENTOMOLOGY.

BY O. W. OESTLUND.

MINNEAPOLIS, MINN., April 1, 1885.

Prof. N. H. Winchell, State geologist:

There is probably, at present, not a crop in this state more threatened and injured by insects than the cabbage. It is for this reason that I submit the following list and notes on insects injurious to the cabbage, as they were observed last summer on the experimental farm of the State University, incomplete as they may be when applied to the whole state, being the observations of but one season and confined to one county. Still, I hope they may have some value to the farmer and gardener in their endeavor to become familiar with and to overcome these pests; being the first record of several of these insects as occurring in Minnesota, they will also have their scientific value.

INSECTS INJURIOUS TO THE CABBAGE.

1.—*Pieris rapæ, Schrank—The white or imported cabbage butterfly.*

This is the most common and destructive of our cabbage insects. It was introduced from Europe, where it also proves quite destructive to the cabbage, about thirty years ago, and has already spread over the greater part of North America, proving that introduced species often flourish exceedingly, and become even more destructive than native species of similar habits. It has, apparently, already settled down for good in this state, and can be considered as a permanent addition to our insect-fauna. I believe that this species is so well known that no description

is necessary for its identification, but as we have several other species similar in habit and hardly less injurious, I shall give a short description of all of them, so that they can be more easily compared and identified by the intelligent farmer and gardener, who may wish to know something about the destroyers of their labor and how they may best free themselves from them.

Description.

The eggs.—These are laid by the white butterfly that we see hovering around our gardens as soon as the tender plants are ready to be set out in the spring, and are continued to be laid for successive broods during the whole season whenever the weather is at all favorable. They are very small; fusiform; ribbed longitudinally, which can be easily seen by a lens; of a light yellowish color, but which soon becomes darker. Generally they are found singly or only a few together on the under side, but also occasionally on the upper side, of the leaves.

The larvæ.—The larvæ, or worms, as they are more commonly called, are rather sluggish in their movements; of a velvety-green color, with black dots, a pale yellowish stripe down the back, and a row of yellow spots on each side. They are generally found in all sizes, from those just hatched to the full grown one, about one and a half inches in length. They are also found to feed upon the cauliflower, turnip, mustard, and other cruciferous plants, though they seem to be very partial to the cabbage.

The chrysalis.—The chrysalis is really an object of beauty and wonder, although we destroy it without consideration, as it proves so destructive to our garden if allowed to develop. It is about three-fourths of an inch long; angulated, and pointed at both ends; in color it varies with minute black dots from grayish-green to quite light. It is found suspended by a web of silk at the end of the body, into which the hooks of the posterior end are twisted, and also by a thread of silk, stretched around the back and fastened to the board, fence or stone under which the larva has chosen its place for transforming.

The imago.—The full developed butterfly has the body black and quite hairy; the wings white above, with a dusky or black space at the tip of the fore wings, and several black spots disposed in a line on the middle of the wings; on the under side the hind pair of wings are yellowish, the fore pair only so on the anterior part. It expands from two to two and a half inches.

Subject to parasites and sickness.

Several parasites are already known to occur in this country on the larvæ of this species, and they will probably prove an effective check on the too great increase in the future. As far as known, none have yet been observed in this state, but if not actually here they will be as sure to occur in due time as the butterfly itself. Parasites generally do spread a great deal slower than the insect on which they live. The larvæ are also known to be subject to some kind of sickness that occasionally carries them off in great numbers. During the past season this has proven to be very generally the case in this state. The cause of this sickness, or epidemic as it might well be called, has not yet been made out to satisfaction, but very probably it is, as has been suggested by some entomologists, some kind of fungus disease or rot, which is favored by the dampness of the weather and the slow vital energies of the larvæ during such times; for it has been observed that during long rains and continued dampness it is very prevalent among the larvæ, while during dry, or only showery, weather, it is rare. The larvæ as soon as affected cease to feed and become even more sluggish in their movements; their bodies become very pale and soft, and some time after they can be seen hanging from one of their legs, or fallen to the ground, and the contents of their body dissolved and running down as a black fluid, leaving only a black streak on the cabbage leaf as the remains of their former existence.

Preventives and remedies.

Whenever the insect can be destroyed in any of its stages it will prove an effective preventive, especially if it be the female. Generally we do not pay any attention to the chrysalids, even if we find them in great numbers on the fences, in the rubbish, etc., around our garden, but we let them all develop into the white butterfly, and this we allow to fly unmolested over our cabbage plants until they have been well stocked with the future brood; and not until the larvæ have become so numerous that they threaten to devour our whole crop, or at least seriously damage it, do we look around for some means of saving it. A great many remedies have been experimented on and proposed, but mostly they are either too costly or impracticable in their application to become of general use. When the crop is too

large to be taken care of by hand-picking, which is the cheapest and surest way in a small garden, we have found the application of hot water to be one of the best. It was tried several times last summer at the experimental farm of the State University, and with very satisfactory results. The thick leaves of the cabbage are such that they can stand water being sprinkled on them at a boiling point without any bad effect, and it will prove a sure destruction to all the larvæ. A good and careful cultivation is also very important. If we neglect our garden or field it will become only a too fit place for injurious insects, and remedies that we may apply will be of little use, while in a clean and well cultivated garden the injury will seldom become serious.

2.—*Plusia brassicæ, Riley.—The cabbage Plusia.*

This is one of the most destructive species to the cabbage in the southern states. It has been recorded as far north in the Mississippi valley as Illinois, but I think this is the first notice of its occurence in Minnesota. I have taken it repeatedly during the last season, both in Ramsey and Hennepin counties, where it by no means is a rare insect; and the extent of its injury is hardly less than that of the foregoing species. From present indications we have much to fear from it in the future. Few of our farmers and gardeners seem to be aware of its existence, but this is probably from the different habit that this species has from the foregoing and more common white cabbage butterfly. The imago, being a moth, is seldom ever noticed in the cabbage field, and the larvæ are in size and color somewhat similar to those of the white butterfly and can therefore be easily overlooked by the untrained observer. The food-plants of the larvæ in their native state are several of our wild herbs, but unfortunately they have also taken a liking to several of our garden plants, as the cabbage, turnip, tomato and celery.

Description.

The eggs.—According to Prof. Riley the eggs are pale, greenish-yellow in color, somewhat convex, and about .55 mm in diameter (.02 inch). From the centre radiate numerous elevated ridges which are divided by transverse and less distinct ridges. They are very loosely attached, either singly or in small clusters, to the leaves, for the most part to the upper, but exceptionally to the lower surface.

The larva.—The larva is light green in color, with several faint white lines along the back; thickest at the posterior end and somewhat tapering in front. It is one of the so-called loopers, and on being disturbed or in rest will raise the middle of the body so as to form a kind of loop and remain in this position sometimes for a long while. It eats long, irregular holes into the cabbage leaves. According to Prof. Riley the larvæ of this species are subject to several parasites and often to a fungus disease, and as they live exposed on the outside of the plant are often devoured in great numbers by birds. As far as my observations go with regard to these points in Minnesota, the larvæ were ordinarily found on the underside of the cabbage leaves, and of all the species I have observed as injurious to the cabbage, this one has been the healthiest and least exposed to parasites. I have raised several hundred of these larvæ and a very small per cent failed to reach maturity, and during cold and damp weather, when nearly every larva of the white butterfly was affected by disease, and even some of the other native species showed weakness, this species seemed to remain unaffected. This would lead us to infer that the species has lately extended its range into this state and has not yet been followed by its ordinary enemies, and finding here an uncontested field, increases without check. If this proves to be so we have much to fear for the coming years until the parasites will also have extended as far.

The pupa.—The pupa is about three-quarters of an inch long; dark brown in color. It can easily be seen through the very loose web-like cocoon that the larva spins around itself before undergoing the transformation. The place for transforming is generally on the leaf or stalk of the plant on which the larva has been feeding.

The imago.—The moth is of a grayish-black color, with a patch of silvery white on the fore pair of wings, and a spot of the same color immediately below this patch; the hind pair of wings are lighter colored, with posterior half blackish and surrounded by a fringe of white; the underside of the moth is of a dull silvery-gray.

Remedies.

This species has shown itself better able to withstand the application of insecticides than any other, and will therefore be

more difficult to get rid of. Hot water will kill the larvæ if it reaches them. We shall probably have to look to the natural enemies as the best check here as elsewhere, if they should prove to become as common as the white butterfly.

3.—*Plutella cruciferarum, Zell.*—*The cabbage Plutella.*

This little moth is very common over the greater part of the United States, and, like closely related species in Europe, proves very destructive to the cabbage, turnip, and similar plants. From the small size of the larva and moth of this species it seems to have been very generally overlooked in this country, and the mischief done by it ascribed to that of the common white butterfly. It has been found very common in Ramsey and Hennepin counties during the past season, and undoubtedly already exists over the whole state where cabbage is cultivated. Fortunately it only attacks the outer leaves, leaving the head uninjured; but it is incessantly at work on those, riddling them with small holes. And during very dry seasons, when they sometimes do multiply exceedingly, they may prove very destructive to the cabbage, and greatly stunt and retard the growth and the formation of the head.

Description.

The eggs.—Eggs were at several times noticed that very probably will prove to be those of this species. They were very small, oblong, about half or a little more than as broad as long; fastened from their side and not base as in those of the white butterfly; color white or whitish; surface very much wrinkled. Generally found singly, but often in clusters of two or more together or in a row.

The larva.—The larvæ are a little over a quarter of an inch long; cylindrical, gradually tapering from the middle towards both ends; color pale green; head and first segment commonly pale yellow. On being disturbed they have a very active wriggling motion, moving briskly backwards or letting themselves fall to the ground by a fine, web-like thread.

The pupa.—When about to pupate the larva spins for itself a very beautiful, gauze-like cocoon, through the wide meshes of which the pupa can plainly be seen, and can generally be found very plentiful on the outer leaves on which the larva feeds. The

pupa itself is about one-fourth of an inch long, of a white color, with the black eyes at the base of the antennæ very conspicuous.

The imago.—The moth measures about .30 in. in length to the tips of the closed wings, and when at rest the antennæ are directed in a straight line forward, and not turned backward as is generally the case. On being disturbed by walking through the cabbage field, it can be seen flying with a very quick motion, but only for a short distance, when it will again alight on some plant until disturbed.

Remedies applied to the other species are also generally very effective on this.

4.—*Ceramica picta, Harris.—The Zebra cabbage worm.*

Harris, some thirty years ago, called attention to this species as occasionally injurious to the cabbage, cauliflower, spinnach, beet, and other garden vegetables with succulent leaves. It has since, at several times, shown itself quite destructive to the cabbage, especially during dry seasons, when the wild plants, upon which it ordinarily lives, have become dried up. It was taken at several times on the cabbage during the last summer, in Minnesota, and must, therefore, be put down as one of our insect enemies to the cabbage against which we need to be on our guard. The larva is very conspicuous on account of the bright yellow markings, or bands, on either side. It lives, exposed, on the leaves of the plants on which it feeds.

Description.

The larva.—When young the larvæ are almost black. They are then gregarious in habit and can be found from twenty-five to fifty or more on a single leaf, but as they grow older they spread all over the field. When full grown they are about two inches in length, of a velvety black color, with the head, legs and under side tawny red; on each side there are two lateral yellow lines and bands, between which are numereus transverse, zebra-like lines, giving to the larva a very characteristic appearance.

The pupa.—The larvæ when full grown go into the ground and there change to the pupa, which is about three-fourths of an inch long, in color shining brown, and rather thickly punctured.

The imago.—The moth is nocturnal in habit, and therefore

seldom seen in the field. It is about the same size as the Plusia moth, but brown in color, shaded with purple-brown. It has three spots on each of the fore wings, edged with gray, and a transverse zigzag line, forming a more or less distinct W in the middle, near the outer margin. The hind wings are white, faintly edged with brown on the upper and outer edges.

On account of the larvæ when young having a gregarious habit, they can then be easily destroyed by cutting off the infested leaf and destroying it. The eggs are hatched in the early part of June, and the young colonies of larvæ should then be looked for.

5.—*Mamestra chenopodii, Albin.—The cabbage Mamestra.*

No injury has been reported or observed as caused by this species in the state, and so far only a few larvæ have been taken on the cabbage; but as it has shown itself very destructive to the cabbage in other parts of the country, it may, under favorable circumstances, become even as destructive here as elsewhere. The larva is easily distinguished from any of the foregoing by a lateral line along its body of pinkish color; the green color varies considerably, from a dark to a light green. The pupa is found in the ground, and the moth is of a yellowish-gray color, varying sometimes to a dark brownish gray. It has not got the silvery spots on the fore wings like those of the Plusia. In case the larvæ of this species should become very numerous and troublesome in this state, entomologists have recommended as the best remedy the use of poisoned turnip leaves as a trap. The leaves should be well covered with a London purple or Paris green solution and placed at intervals along the rows.

6.—*Murgantia histrionica, Hahn.—The harlequin cabbage-bug.*

During last summer some of the very characteristic eggs of this species were taken on the cabbage on the experimental farm of the University, giving indications of a new insect pest for the cabbage in this state. It is a southern insect, but has been known to extend its range northward from year to year, as the Colorado beetle extended its range eastward, though its progress has been a good deal slower. It has been recorded in the Mississippi valley as far north as Illinois, and Professor Lintner, in his first report as state entomologist of New York, intimates

that it is capable of extending its range as far north as to include Minnesota and Wisconsin. In the south it is one of the most destructive insects to the cabbage. It is not a larva or worm like the foregoing species we have noticed, but it belongs to the order Hemiptera, or true bugs, such as the plant lice, squash-bug, and similar ones, which are provided with a beak, or *rostrum*, as it is called, which they thrust into the plants on which they live and imbibe the sap, thereby injuring or killing the plant when they become very numerous. Although only the eggs have as yet been observed in this state, it is very probable that in the near future we shall have all the stages, and if it should prove to be as destructive here as further south we have another species that will not stand back to that of the white butterfly in the extent of its injury. I shall therefore call attention to it that our farmers and gardeners may be on the watch. As I have not had the opportunity to study this species in the different stages, having only seen the eggs, I shall give the description of Prof. Lintner, found in the report alluded to above. Any information or inquiry with regard to this species will be gladly received.

Description.

Eggs.—The eggs are beautiful objects, and are easily recognizable. They are cylindrical, with rounded extremities, placed on end, and cemented together by their sides. They are white, tinged with green, apically, with two black bands, the upper one of which is twice as broad as the lower, and placed a little nearer to the extremity of the egg. The apex is strikingly marked with a black crescent bordering the slightly-depressed lid (which opens upon a hinge for the escape of the larva), and occupying rather more than one-half of its circumference. The length of the egg is about one-half greater than its diameter, measuring .034 inch by .052 inch. They are arranged in two to four rows of three to six eggs in each row.

The larva.—The larvæ are small, pale-green, and when more advanced become orange-colored.

The pupa.—The pupa resembles the perfect insect in marking and coloring, but may be at once distinguished by having wing pads instead of wings, and is not capable of flight.

The imago.—Measures three-eighths of an inch in length by nearly one-fourth in width. It is conspicuously marked in shining blue-black, dull orange and white, as follows: The black

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head has two short lines upon it of yellowish white; the thorax is orange, with a ring of black on each side, centered with a triangular orange spot, or with the black diminished and the ring either interrupted or broken into two spots. The coriaceous portions of the wing-covers are orange, crossed obliquely by two black bands, and their tips are black. The scutel (the large triangular piece covering the central portion of the body) is black, with a pale yellow spot at each anterior angle, a black terminal tip and a central cross of orange. Beneath, the joints of the abdomen bear upon their margin a row of triangular white spots, and intermediately there are three rows of particolored spots in orange and white.

No parasites are as yet known to prey upon this species, and it has been found very difficult to destroy by any ordinary application of insecticides.

7.—*Aphis brassicæ, Linn.—The cabbage plant-louse.*

The Aphidæ, or plant-lice, become at times the greatest torments to the gardener and agriculturist. There is hardly a plant that has not a species or more of this pest living upon it, and often great injury is done. The plant-lice belong to the order Hemiptera, or true bugs, and, like the foregoing species, are provided with a beak, which they thrust into the plant and suck the juices. The cabbage plant-louse has been found more or less common through the state, and is probably the most widespread species of those injurious to the cabbage. They are found in clusters or colonies on the upper side of the inner, or under side of the outer, leaves, but also sometimes solitary. The colonies are made up of wingless individuals of all sizes, and, further on in the season, also of winged individuals.

The young individuals are egg-shaped and of a dull, pale-green color, and their bodies dusted over with a pale-grayish powder. Antennæ and legs dusky black.

The females, or largest wingless individuals, are also coated with a gray, meal-like powder; egg-shaped and of a dull, yellowish-green color; eyes black, and also two large spots on the crown and one on each side of the neck; antennæ black, with the third joint yellowish. The nectaries, or honey-tubes, are short and black, as are the legs; base of the thighs pale-yellowish; body plump, large and unwieldy in its aspect, and about a tenth of an inch in length.

Winged individuals are dull-greenish in color, varying to pale dull-yellowish, and largely varied with black.

Remedies.

Fortunately this species has a great many enemies that ordinarily keep it within bounds, and it is only occasionally that they do multiply in such great numbers as to destroy or seriously damage a crop. Whenever a leaf is found affected it should be cut off and destroyed, so as to prevent, as much as possible, the spreading over the whole field. When very numerous, kerosene emulsion has been found very effective.

8.—*Haltica pubescens, Illiger.*

9.—*Crioceris striolata, Fab.*

The flea-beetles.

The little flea-beetles, as they are called on account of their jumping to an incredible hight on being disturbed, are very similar in habit and appearance to each other. They are found destructive, not only to the cabbage, but to most of our garden vegetables, by nibbling small holes into the leaves as soon as they come out of the ground, and continue to do so during the whole season. Often they so injure a bed of vegetables as to necessitate replanting. They are both very small, less than a tenth of an inch, and shining black; the second with a broad, wavy, buff-colored stripe on each side, and the feet reddish-yellow. The thighs of the hind pair of legs are very much thickened, like those of the grasshopper, giving them the great leaping power. They have been found very difficult to get rid of by any ordinary application of insecticides. Ashes sprinkled over the young plants will drive them off, to some extent. Frogs are known to destroy them in great numbers when found and allowed in gardens.

Other species will undoubtedly have to be added to this list in the future, as observations extend, but still we should hope not, as the cabbage-grower surely has sufficient with the evil as it at present appears.

Respectfully,

O. W. OESTLUND.

XVI.

THE CRYSTALLINE ROCKS OF THE NORTHWEST.*

I desire to call the attention of Section E to some of the interesting problems that beset the geologist who undertakes to study the crystalline rocks of the Northwest, and especially that part of the Northwest which is included in the state of Minnesota. Until very recently it has been the practice of geologists, almost without exception, to refer every crystalline rock in the Northwest either to the Huronian or to the Laurentian. Thus, when the survey of the state of Michigan was reinaugurated in 1869, the geologists of the upper peninsula were compelled to choose between a confession of their inability to establish the age of the rocks they were studying and the adoption of some of the recognized designations. In Wisconsin the case was similar, with the additional fact that the Michigan geologists were collaborators. The same was true again in Minnesota. What more natural than that the Michigan and Wisconsin rocks should be found to extend, with nearly the same features, into the state of Minnesota, and that their familiar names should at once be applied to them?

But when on more careful examination, both in the field and in the literature of the crystalline rocks, and over a wider extent of territory, and especially in the light of more recent researches in New England, New York, Pennsylvania, and Canada, it is found that the nomenclature is imperfect, and furnishes but a tottering scaffold to support the workmen of a great and ever-spreading structure, we are thrown into such difficulty and doubt that we are prone either to reject the old scaffold and build anew, or to clear away the accumulated rubbish about the foundation and examine on what basis the old one stands. To-day, however, we intend to do neither of these, but rather set forth a few of the incongruities and difficulties of the actual situation.

*Address of N. H. Winchell, Vice-President of Section E, at the Philadelphia meeting (1884) of the American Association for the Advancement of Science.

We are indebted, unquestionably, to the geologists of Michigan and Wisconsin for the most exhaustive and satisfactory description of the crystalline rocks of the Archæan age that has yet been published in America. In order that some of the difficulties of the situation may be made clear, I desire to review concisely the broad stratigraphic distinctions of the crystalline rocks that have lately been studied in Michigan, Wisconsin and Minnesota. By the aid of the published results of the surveys of Brooks, Wright, Irving, Rominger, Pumpelly, and others, a generalized statement can be formulated. To these I shall add such published results and unpublished field observations from Minnesota as may be furnished by the survey of that state, in order that the scheme may cover correctly the crystalline rocks of the entire Northwest.

Omitting the igneous rocks, which in the form of dykes cut through the shales and sandstones of the Cupriferous formation, and are interbedded with them in the form of overflows, we may concisely arrange the crystalline rocks, disregarding minor differences and collating only the broad stratigraphic distinctions, in the following manner, in descending order:

There are six groups:

First group.

Granite and gneiss with gabbro.—This group is represented in Minnesota by the gabbro and red syenite at Duluth, and by the extension of this range of hills northeastwardly nearly to the international boundary. Its thickness is unknown, but certainly reaches several hundred feet. The outcrop of red granite near New Ulm, lying under the conglomerate and red quartzyte, is probably in the southwestward line of extension of this group. This group is represented by No. XX southwest of lake Michigamme, by No. XX at Menominee and by No. 1 and 1a at Black river.

Second group.

Mica schist.—This group consists of schists that are micaceous and often staurolitic as well as garnetiferous. It can be seen in Minnesota on the Mississippi river at Little Falls, and at Pike rapids. The schists are variously associated with beds and veins of granite and gneiss. This is No. XIX at Marquette, XVII to XIX

at Menominee, XX to XXII at Penokee, and has a maximum thickness of 5,000 feet.

Third group.

Carbonaceous and arenaceous black slates, and black mica-schists.—These sometimes pass into roofing slates, with beds of iron ore, quartzyte and dioryte. This group includes the black slates of the Animikie group in northern Minnesota, of Knife lake and Knife portage on the St. Louis river, and carbonaceous slates lately reported near Aitkin on the Mississippi river. It includes Nos. XIV to XVII at Marquette, Nos. VI to XVII at Penokee, and Nos. XV and XVI at Menominee. Thickness 2,600 feet.

Fourth group.

Hydro-mica and magnesian schists.—Soft and obscure, becoming quartzose and also hæmatitic, also with numerous beds of dioryte. In Minnesota this is the iron-bearing horizon at Vermilion lake. It is Nos. VI to XIV at Marquette, Nos. IV to VI at Penokee, and Nos. VI to XI at Menominee. Maximum thickness 4,450 feet.

Fifth group.

This is the group of *gray quartzyte and marble.* It is represented by No. V at Marquette, Nos. II to V at Menominee and Nos. I to III at Penokee. In Minnesota this horizon seems to run along the south side of Ogishke Muncie lake, near the international boundary and includes perhaps the great slate-conglomerate which is there represented. Normal thickness from 400 to 1,000 feet; but if the great conglomerate of Ogishke Muncie be included here, the thickness of this group in northern Minnesota will exceed 6,000 feet.

Sixth group.

Granite and syenite with hornblendic schists.—This lowest recognized horizon has frequently been styled Laurentian. In Minnesota it is found on the international boundary at Saganaga lake, and large boulders from it are included in the overlying conglomerate at Ogishke Muncie lake, showing an important break in the stratigraphy. Thickness unknown but very great.

These six great groups compose, so far as can be stated now, the crystalline rocks of the Northwest. Their geographic relations to the non-crystalline rocks, if not their stratigraphic, have been so well ascertained, that it can be stated confidently that they are all older than the Cupriferous series of lake Superior, and hence do not consist of nor include metamorphosed sediments of Silurian or any later age.[1]

This statement of the grand grouping of the crystalline terranes of the Northwest may be varied by the addition of detailed and minor distinctions and by subdivisions, but its correctness rests upon careful observations and reports of competent geologists, and cannot at present be gainsaid.

Examining these groups more closely we find:

I. We have beneath the red tilted shales and sandstones, a great *granite and gabbro group*. This has been variously regarded by different geologists. While by many early observers it was classed as older than the series which has latterly been designated Huronian, and by others styled igneous and local, it has by Brooks been placed with that series and denominated "the youngest" of the Huronian strata, though no such rocks had ever before been mentioned as pertaining to the Huronian. By Irving it has been made the base of his Kewenawan. By Hunt it has been parallelized with the Montalban. It includes, in my opinion, the felsytes and porphyries which have been styled Arvonian, and it is very certain that in many places it has passed for typical Laurentian. The gabbro is very generally admitted to be of eruptive origin, and in its great development in Canada it was once styled Upper Laurentian, and later was known as Norian. While the gabbro is certainly eruptive, the associated granite and gneiss exhibit evidences of being metamorphic in their nature. In northern Minnesota this horizon of granite is characterized by a red color and it has an aggregate chemical composition almost identical with that of some of the associated felsytes. The magnetite of the gabbro is often highly titaniferous and so abundant that the rock has attracted attention as an iron ore. The gabbro does not always appear where the granite is present, but extensive areas of granite are spread out without any sign of variation, interruption or alternation with the gabbro. In other places these two rocks are intricately and intimately mingled both horizontally and perpendicularly; but the gabbro may be considered in

[1] The term Silurian here is understood to cover nothing below the base of the Trenton.

general as the underlying formation. Both these rocks seem to have been molten, and simultaneously so, in some places; but in the great mass of the red, granitic rock, there is a gneissic structure, and in its finely crystalline state, when it seems to vary to felsyte, it exhibits a laminated structure which is evidently due originally to sedimentation. Along these laminations, and coincident with them, is a finely lined striation which exhibits the "streamed" structure, sometimes appealed to, to show the igneous nature and origin of the rock. These felsytes are occasionally arenaceous, with irregularly rounded or subangular quartz grains, and sometimes are porphyritic with quartz and orthoclase. Veins of red granite intersect the gabbro, and the gabbro surrounds isolated masses of the granite. Transported, boulder-like masses of both are found embraced in a common paste among the later igneous outflows of the Cupriferous, where their existence is as great a puzzle as that of pebbles of red felsyte and quartz-porphyry in the red conglomerates. This red granite, so far as I have observed, generally consists largely of orthoclase, and in several instances passes imperceptibly into red felsyte. It contains also quartz and hornblende, the latter generally changed by decay. The gabbro, when unaffected by proximity to the red rock, consists of the three essential ingredients: labradorite, diallage and magnetite, with some necessary products of alteration, but in the vicinity of contact with the red rock it also holds orthoclase and quartz.

II. Below this granite and gabbro group is a series of strata that may be designated by the general term *mica schist group*. This is the principal, but not the only, horizon in which mica schist exists. This division is penetrated by veins and masses of red biotite-granite, which appear to be intrusive in somewhat the same manner as the red granite in the gabbro overlying. However, whether this granite is exotic, or can be referred to aqueo-igneous fusion and transmission of the sedimentaries in a plastic state through fissures in the adjacent formations, is a question which still is a matter of earnest investigation. The existence of the great associated igneous gabbro is suggestive, if not demonstrative, of the presence of an adequate agent for such a metamorphism — unless it be claimed, indeed, that such an extravasation of molten rock could take place without any marked and traceable effect on the contiguous formations. These granite veins penetrate only through the overlying gabbro and this underlying mica schist. They are wanting or comparatively

rare throughout the rest of the crystalline rocks. On the other hand there is an abundance of diabase and other doleritic rock, in the form of dykes, throughout all the crystalline strata. This points to the mere local nature of the origination of these granitic veins, and hence to the metamorphic nature of the granitic mass with which they are connected. It has been shown by Dana that granite suffers a change to mica schist, in western Massachusetts; Brooks, as well as Emmons, has shown it interstratified with limestone in St. Lawrence county, New York. They both also state that the Potsdam sandstone becomes gneissic. The same has been affirmed in Vermont by Dr. Hitchcock, and by Dr. Frazer in Pennsylvania. Hence, there is no impropriety in supposing that some great change has passed over the sedimentary strata of this horizon throughout a wide extent of country reaching from the Atlantic to lake Superior, and that in the emergences of upheaval and dislocation the sediments of one formation were enabled to penetrate transversely into the strata of another.

This mica schist formation has an aggregate thickness of about 5,000 feet, and sometimes is hornblendic rather than micaceous.

III. The next lower grand division, which is the third, might be styled the *black mica slate group*. This group contains much carbon, causing it to take the form of graphitic schists, in which the carbon sometimes amounts to over forty per cent.[2] These schists are frequently quartzose, and also ferruginous, even composing valuable ore deposits, as at the Commonwealth mine in Wisconsin. Associated with these black mica slates, which often appear also as dark clay slates, are actinolitic schists, the whole being, in some places, interstratified with dioryte. Their estimated thickness is 2,600 feet.

IV. Underneath this is a very thick series of obscure, *hydromicaceous and greenish magnesian schists*, in which, along with beds of gray quartzyte, and clay slates, occur the most important deposits of hæmatitic iron ore. The lower portion of this series, which at Marquette is represented rather by hornblende and chloritic quartz schists, and more rarely is mined as a magnetic quartz schist, at Penokee is known as "the magnetic belt." This division of the crystalline rocks has numerous heavy beds of dioryte.

V. Below this series of soft schists, which terminate downward

[2] A recent analysis of a specimen from near Aitkin, Minnesota, showed between forty-two and forty-three per cent of carbon.

with the magnetic iron ores, is the great *quartzyte and marble group.* The marble lies above the quartzyte, and in the Menominee region has a minimum thickness of at least one thousand feet; while at Marquette it graduates into a dolomitic quartzyte of indefinite extent, the whole group there being essentially a quartzyte. This is a most persistent and well-marked horizon. The quartzyte sometimes holds feldspar; thus having an appearance of granulite. In northern Minnesota, the great slate-conglomerate of Ogishke Muncie lake seems to represent the lower portion of the great quartzyte of this group, and to be the equivalent of the lower slate-conglomerate of the "typical Huronian," in Canada. In both places this conglomerate is sometimes speckled with masses of red jasper. The marble of this group appears adjacent to the conglomerate south of Ogishke Muncie lake, and in such a position as to overlie it, exposing a thickness of at least twenty-two feet.

Now, the difficulties of the situation arise when we cast about to find names for these parts. What are the eastern representatives of these western groups, and by what designations shall they be known?

Since the geological survey of New York, and the publication of its final report, the progress of geological science in Europe and America has rendered it necessary to revise some of the dogmas which were regarded as fundamental by the New York geologists, and to reject entirely some others. Among these may be mentioned the then current theory that the term "primary" should be applied to any massively crystalline rock, and that all such rocks belong to the bottom of the chronological scale of geology. If the apparent structural relations of the formations, as seen in the field, did not agree with this theory, some violent movement in the earth's crust was at once conjectured so as to bring nature into accordance with the true theory. Latterly, however, it has been shown abundantly by Dana and others, that the Trenton, Hudson river and other Silurian rocks are converted into crystalline schists; by Whitney that the Tertiary rocks become crystalline; by Brooks and Frazer that the Potsdam sandstone becomes gneissic; by Reusch that the clay slates, interbedded with the granites and gneisses of the Bergen peninsula of Norway,[3] contain characteristic Upper Silurian fossils, and by Hitchcock that the Helderberg rocks of New York are involved in the crystalline terranes of New Hampshire.

3Lesley, Report C4.

These more recent crystalline series, however, may all be considered as excluded from the scope of search for any parallels to the crystalline groups of the Northwest. Our inquiry will involve only the well-known names Laurentian, Huronian, Taconic, Montalban, Arvonian, Norian.

We meet at the outset with the question which has now become as historic in American geology as the Cambro-Silurian controversy in England, and which concerns very nearly the same geological horizon, viz.: Is there a formation such as claimed by Emmons — the Taconic? On this geologists are yet divided. We conceive, however, that the division is caused, not so much by doubt as to the existence of a sedimentary fossiliferous formation below the New York system, and separating it from the "primary," as by doubt as to which and how many of these sub-Silurian strata are to be included in the designation of Taconic. Having now, however, given the subject very careful consideration, I am ready to state my very positive conviction that Dr. Emmons was essentially right, and that the Taconic group will have to be recognized by geologists and adopted in the literature of American geology.

Dr. Emmons, in 1842, issued the first that appeared of the volumes of the final report of the New York survey. In that volume he formally sets forth the Taconic system, although, as he admits, in an imperfect manner, the area in which the rocks exist not being in his (the second) district. In this first presentation of the system he extended it geographically too far east, and unfortunately chose a name for it which is appropriate only to a part of that eastward extension. We are indebted to the researches of several volunteer geologists, Wing, Dana, Dale, Dwight, for the disentanglement of the overlying Hudson river rocks from the true Taconic rocks, and the demonstration of the incorrectness of Dr. Emmons' eastward extension of his system in southern Vermont. Dr. Emmons' claim, however, in all its essential points, remains intact. This consists in the existence of a series of sedimentary deposits, largely metamorphic, below the Potsdam sandstone, and separating the Postdam from the crystalline rocks known as "primary," in an orderly chronological scheme.

In his report on the agriculture of New York, issued four years after that on the geology of the second district, he makes more definite and convincing statements, going over the whole subject *de novo*. He gives diagrams showing the Taconic slates lying below the Calciferous sandrock unconformably, at White-

hall in Washington county, a region that had been colored by Mather and Hall on their geological maps as Hudson River, and lying in the general area described by Emmons as Taconic. He gives one also from the hills of Greenbush, opposite Albany, not far from the locality in which Mr. Ford has since discovered primordial fossils, where he also shows the Calciferous lying unconformably upon the Taconic, the former being fossiliferous. He also describes the Hudson River slates as lying unconformably on the Taconic, a fact which cannot be called in question since the recent discoveries of Wing, Dale and Dwight, and the stratigraphic investigations of Dana. In fact, the investigations of these geologists, instead of destroying the Taconic system, are only confirmatory of the published statements of Dr. Emmons in 1846.

Although the existence of the Taconic in Maine and Rhode Island, as claimed by Dr. Emmons, may not be maintained by further research, it is certain that he had the approval of Dr. Douglas Houghton in extending it into the state of Michigan. In later years, he also traced these rocks through Pennsylvania and Virginia into North Carolina. In Michigan his identifications have since been set aside and the same rocks have been denominated Huronian by Brooks, Wright, Irving and others. In North Carolina Mr. Kerr has, in the same way, substituted the name Huronian. The conclusive fact that these slates had been seen by Dr. Houghton, in many localities, to pass beneath the Potsdam sandstone, was considered ample to supply the only important point of evidence lacking in the Hudson valley. Dr. Emmons closes his discussion by stating his theme thus, referring to the facts obtained from Dr. Houghton: "It would be difficult to add to the weight of this testimony in regard to the separate and independent existence of a system of fossiliferous rocks, of an age anterior to the Silurian or New York system."

It is not necessary to refer to the controversies that arose from the creation of the imaginary Quebec group, nor to characterize in deserved terms the attempt to bury the Taconic in the Quebec coffin. It is not necessary to quote the support which Emmons had from Barrande, nor to recount the discoveries of Mr. Ford, nor the observations of Brooks in St. Lawrence county, N. Y., and Rogers in Pennsylvania, though these last both affirm that beneath the Potsdam sandstone are extensive beds of semi-crystalline strata.[4]

[4] Address of H. D. Rogers, 1844, before the Assoc. Amer. Geol. and Nat.

There may be reasons why the current literature of American geology is almost silent respecting the great work of Emmons, and why the Taconic is not known among the recognized geological formations; but we have nothing to do with these at this time. We have to say now only that it seems necessary to admit that when Dr. Emmons insisted on a great group of strata belonging to the age of the Lower Cambrian, lying below the Potsdam sandrock in New York, he had some foundation more substantial than imagination or mere hypothesis. He may have chosen an unfortunate designation, he may have but imperfectly understood the extent and importance of his discovery, and he may have incorrectly described its range and scope, but none of these faults, nor all of them, should deprive him of the credit of having made the discovery. He did more, he defended it to the last day of his life, and averred that "the Taconic system stands out as boldly as the Carboniferous."[5] The argument against the Taconic system, which appeals to imperfect or incorrect definition by its author, will apply with equal force against the Silurian system and also against the Cambrian; also against the Huronian and Laurentian, and perhaps with still greater force against the Hudson River, since none of these were correctly and properly defined at first by their authors.

If the equities of geological nomenclature, in the light of the results of later researches, demand of geologists of this generation a fair consideration of the claims of Dr. Emmons, that consideration must be granted. No amount of error, though heaped to the sky and supported by the highest authority, can long subsist. The truth, though tardy in asserting itself, will finally throw off the burdens under which it has labored, and will shine the brighter for the darkness which preceded it.

If we examine the descriptions, given by Dr. Emmons, of his Taconic system, we shall find that he makes the following broad stratigraphic distinctions:

I. His highest member is what he designates *black slate*, which he declares, in some cases, plunges apparently beneath the "ancient gneisses" and contains a considerable amount of carbonaceous matter. In this slate, at Bald mountain, were found two genera of primordial trilobites that were described by Dr. Emmons, the much buffeted *Atops trilineatus*[6] and *Elliptocephala asaphoides*.

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[5] Letter to Jules Marcou, dated Raleigh, N. C., Nov. 6, 1860.

[6] According to Mr. Ford this is *Conochoryphe*.

II. Under the black slate his next grand distinction was the so-called *Taconic slate*, which he described as argillaceous, siliceous and "talcose," the upper part being suitable for roofing and other portions adapted for flagging. It is greenish, grayish and sometimes of a chocolate color. Its grain is very fine, but in some places it is arenaceous rather than argillaceous. Thickness about 2,000 feet.

III. Below this great mass of soft schists, he described, in the first place, a mass of 500 feet of limestone, designated "Stockbridge limestone," which graduates downward into "talcose" or magnesian sandstones and slates, the whole having a thickness of about 1,700 feet.

IV. Under this limestone is his "granular quartz-rock," more or less interstratified with slates, and becoming, in some places, an immense conglomerate with a "chloritic paste." In this conglomerate are fragments of the underlying gneiss, or

V. A formation which constituted, in his scheme, the "ancient gneiss" on which the Taconic system was said to lie unconformably.

Now it requires but a glance to perceive how closely this order coincides with that which has been independently and laboriously worked out in the Northwest. We have in both instances a "black slate" which in one case is said to be at the top of the system, but to pass apparently beneath the "ancient gneisses," and in the other is reported to be overlain by a group of mica schist and the "youngest Huronian," a mass of gneiss and gabbro. Below the black slate in both cases is an immense series of soft, hydro-mica and magnesian schists. These again are followed by limestone which in the Northwest often forms marble, and in New England sustains extensive marble quarries. This has various transitions to slate and to a hard sandrock, but in both places it becomes known, in its lower portions, as a great bed of quartzyte; and finally at the base is coarsely conglomeritic with masses of rock from the great underlying series of gneiss. Were there no other precedent this very parallelism would be taken at once as demonstrative, or at least indicative, of equivalence of age. The "Stockbridge limestone," however, at Stockbridge, seems to be of the Trenton age, according to Professor Dana; and where it appears in the Taconic mountains, further south and west, it is assumed by him to be of the same formation. But no one can affirm safely that the Taconic range of mountains is made up of the Trenton and Hudson River for-

mations till the crucial test has been applied to them successfully in the discovery of the characteristic fossils, and assuredly not, in the absences of this test, in the face of the foregoing parallelism with a limestone known to lie much lower; and in the face of the discovery of primordial fossils in Bald mountain some miles further north in Washington county, New York. It is to be remembered also that the schists of Mt. Washington are distinctly different from those of southern Vermont containing the Trenton fossils found by Mr. Wing, "a change" taking place in them not far south from the point at which the fossils were found, continuing thence to the southern extremity of Mt. Washington.[7]

Now, however, we are confronted with another difficulty. The geologists of Michigan and Wisconsin have set aside Dr. Emmons' identification of the Menominee rocks with the Taconic in 1846, and have called them Huronian, the same that has been done in North Carolina by Mr. Kerr, parallelizing them with the Canadian system, which in 1855 was so named by Dr. T. Sterry Hunt.[8]

It becomes necessary, therefore, to ascertain of what the Huronian consists. Dr. Hunt sets out with the statement that it was designed to include the younger and unconformable series of metamorphic rocks found on the shore of lake Huron and in the valley of the Thessalon river, "and also the so-called volcanic formations of lake Superior." Thus the avowed intent was the same as that of Dr. Emmons in erecting the Taconic system. If we seek for the actual stratigraphic and mineralogical characters of these rocks, we shall find them in the geological reports of the Canadian survey, particularly that of 1863.

In descending order the original Huronian consists of the following strata, disregarding the diorytes and other "greenstones," all of which are thought by Logan to be of igneous origin, though included in the thicknesses given.

White quartzyte	400 feet.
Limestone	200 "
White quartzyte	1500 "
Limestone, siliceous and cherty	400 "
White quartzyte	2970 "
Red jasper conglomerate	2150 "
Red quartzyte or conglomerate	2300 "

7 Dana, *Amer. Jour. Sci.* (3) XVII, 376.

8 Equisse geologique du Canada; Azoic rocks, Rep. E, p. 72.

Slate conglomerate	3000 "
Limestone	300 "
Slate conglomerate	1280 "
White quartzyte	1000 "
Chloritic and epidotic slates	2000 "
Gray quartzyte	500 "
Total	18000 "

Of this series of 18,000 feet, 900 feet consist of limestone; 2,000 feet consist of "chloritic and epidotic slates," and 15,100 feet consist of quartzyte and conglomerate. Perhaps 5,000 feet of this last thickness may be considered intrusive, consisting of dioryte and other forms of "greenstone." This will leave 10,000 feet, at least, for the aggregate thickness of quartzyte and conglomerate, being nearly double that observed in the same horizon in northern Minnesota.

It is plain to see that if there be any parallelism between these beds and the various groups made out in the Northwest, the whole of these strata must be made the equivalent of group V, or the *quartzyte and marble group.* The 2,000 feet of chloritic and epidotic slates, represented as near the base of the original Huronian, followed as they are by an immense thickness of conglomerate and slate conglomerate, are anomalous unless there be below them other slate conglomerates. This, indeed, is very probable, since, on the shore of lake Superior, near the mouth of the river Doré, according to the same authority, the lowest part of the Huronian is seen to consist of a green slaty conglomerate, containing "boulders" of granite and gneiss.

The extension of the term Huronian from the horizon of the original Huronian, upward through the overlying groups, may be justified by the expression of the original intent in the application of the term, but it certainly does not seem warranted by any description of rocks by the Canadian geologists, nor by any claim that usually has been put forth by the authors of the name.

There is, therefore, a conflict between the Taconic and the Huronian, both in respect to the horizon which they are intended to cover (both being referred by their authors to the Lower Cambrian) and in the horizon of rocks which they actually compass. The Huronian, however, in its original and typical description, can be parallelized with only the very lowest of the strata that were included in the typical and original Taconic; while the Taconic stretches upward at least as far as to include

the fourth and third grand groups made out in the Northwest, that is to say, the *hydro-mica and magnesian schists*, and the *carbonaceous and arenaceous black slates.*

This leaves two series of rocks untouched by the scope of either the Huronian or the Taconic, as these systems were at first defined, namely: the *mica schist group* and the *granite and gneiss with gabbro group.* In the term *Montalban* proposed for these groups by Dr. Hunt, the two are united and the constant distinctness which they seem to maintain is not recognized. The granite and gabbro group has affinities with the overlying *Cupriferous rocks*, and perhaps, as Irving has suggested, should be considered the base of that series which Brooks has named "Kewenawian," whereas the mica schist group has affinities with the underlying groups, and has, without exception, been assigned to the same system and age as those underlying groups. The granite and gabbro group has likewise been designated differently. The gabbro, being an igneous rock, varies much in its prevalence and in its apparent relation to the granite. Its greatest development produces in Minnesota a range of low hills which extend northeastward from Duluth. Under similar circumstances, this group has received the name *Norian*, though at first called *Labradorian*, and thought to be a part of the Laurentian.[9] The granite and gneiss, also, associated with the gabbro, have received, under one of their modified conditions, the special designation *Arvonian*, on the supposition that these rocks where they so appear, are not modified conditions of granite and gneiss, but represent independent strata that lie near the bottom of the "Huronian," equal in rank to any of the other groups. I think I have shown elsewhere[10] that the Arvonian rocks of lake Superior are interstratified with the Cupriferous, and also that they are modified sediments of the Cupriferous. Instead of being near the bottom of the "Huronian" in the Northwest, they overlie all the other groups that have been assigned to the Huronian by Irving, and constitute a part of the great series of "younger gneisses" which by Brooks has been ranked as the "youngest Huronian."

The interesting variety of nomenclature, as brought out by the foregoing remarks, can be seen by a glance at the accompanying tabular arrangement, where the various parallelisms and the conflicting nomenclature are placed in adjoining columns.

It is evident from this table that at present it is a hazardous,

[9] It was described by Emmons under the term "Hypersthene rock."

[10] A. A. A. S. Cincinnati meeting; Minnesota Survey Rep. for 1880, p. 36; *ibid*, 1881, p. 110.

and perhaps an impossible, undertaking to assign the groups of the crystalline rocks of the Northwest to any of the terranes that have been named further east, without violating somebody's system of nomenclature. Some of the ground has been covered several times by different names, but on different hypotheses of structure, origin and parallelism. Respecting the horizon known as "Laurentian," there is an approach to unanimity and agreement. This, however, consists more in a tacit consent to style the lowest known rocks Laurentian, than in any agreement among geologists as to the nature and composition of the strata. The Taconic of Emmons, which has been buffeted and combated from the day of its birth, has from that very circumstance been generally ignored by geologists, because of a certain air of dubious authenticity which accompanies the word. The term Huronian has been allowed to stand and to flourish, partly because of the high authority on which it rests and the remoteness and inaccessibility of the typical locality, and partly, at first, because of the non-publication of Dr. Emmons' protestation that it was the equivalent of some part of his Taconic, and later, because, after Emmons' death, as well as before, his opponents were active in spreading views adverse to the Taconic system throughout the literature of American geology. The original Huronian has grown from the dimensions of a single group (the quartzyte and marble group), so as to include all the crystalline rocks lying above that group, spreading from the Laurentian to the unchanged sediments of the Upper Cambrian. This has become so obviously wrong, in some cases, and has included groups of rocks so plainly extra-Huronian, that a double and triple nomenclature has been applied to a part of these upper rocks, for the purpose of relieving the term of the heterogeneous burden which it was otherwise compelled to carry. These new names, with the exception of Montalban, seem to be of value only as regional designations, the strata which they represent being igneous or metamorphic, and hence liable to be wanting in some places and to be non-crystalline in others. They further complicate the stratigraphic nomenclature, since the strata are probably only the locally modified parts of the same system. Their geographic distribution in the Northwest not only indicates their stratigraphic horizon, but also their limited and local existence.

In conclusion, the chief points brought out in this discussion may be stated more concisely:

1. The crystalline rocks of the Northwest are comprised under six well-marked comprehensive groups.

2. The Taconic of Emmons, so named in 1842, and more correctly defined in 1846, included three of these groups.

3. The Huronian of Canada is the equivalent of the lowest of the Taconic groups, and the perfect parallel of only the lowest of the groups in the Northwest that have been designated Huronian.

4. The uppermost of the groups in the Northwest is local in its existence and exceptional in its character, and has received, therefore, a variety of names.

5. There are, therefore, confusion and conflict of authority in the application of names to the crystalline rocks of the Northwest.

GROUPS.	EMMONS.	HUNT.	BROOKS.	IRVING.	EQUIVALENTS IN MICHIGAN.	EQUIVALENTS IN WISCONSIN.	EQUIVALENTS IN MINNESOTA.
GROUP I. Granite and Syenite with Gabbro.	Hypersthene Rock. (Regarded as part of the primary.)	Montalban. Labradorian. Norian. Upper Laurentian. Arvonian.	Youngest Huronian.	Base of the Keweenawan.	XX.	I and Ia at Black river.	Duluth. Brule Mountain. Misquah hills. Beaver Bay
GROUP II. Mica Schist.					XIX at Marquette. XVII–XIX at Menominee.	XX–XXII at Penokee.	Little Falls. Pike Rapids. Outlet of Vermilion lake.
GROUP III. Carbonaceous and Arenaceous Black Slate.	Taconic System. 1842–1846. Black Slate.	Animikie.	The Huronian of Brooks. 1873.	The Huronian of Irving. 1879.	XIV–XVII at Marquette. XV and XVI at Menominee.	VI–XVI at Penokee.	Animikie Black Slates. Grand Portage.
GROUP IV. Hydromica and Magnesian Slate.	Taconic Slate.				VI–XIV at Marquette. VI–XI at Menominee.	IV–VI at Penokee.	At "The Mission" Vermilion lake. Vermilion Iron Mines.
GROUP V. Quartzyte and Marble	Stockbridge Marble. Granular Quartz Rock.	The Huronian of Canada, 1855.			V at Marquette. II–V at Menominee.	I–III at Penokee.	Ogishke-Muncie lake.
GROUP VI. Granite and Gneiss with Hornblendic Gneiss.	Primary.	Laurentian.	Laurentian.	Laurentian.	Laurentian.	Laurentian.	Laurentian.

XVII.

GEOLOGICAL NOTES IN BLUE EARTH COUNTY.

BY PROF. A. F. BECHDOLT.

Interglacial peat.— Some time ago Mr. Z. Harrington, of Mankato, showed me a section, a foot long, four inches wide and three inches thick, composed of organic matter, mainly compacted leaves, sedges, etc., and resembling a poor lignite or compressed peat. When first seen it was yet moist, and could be cut like hard soap. The layers, of which it is composed, were also somewhat elastic. On drying it became harder, more brittle, and cut like wood. On Saturday, October 18th, I visited the place, in company with Dr. Harrington, where it is found. This is in Mankato township on the land of Messrs. Pleasanton and Powell, in the bluff of a ravine bearing a stream that flows into the Le Sueur river from the north. This organic deposit is seen in both banks of the ravine, and can easily be traced horizontally about three hundred feet, and then is lost. It has a pretty uniform thickness of about two feet, is overlaid by about six feet of dark drab clay containing some pebbles of quartz, limestone and shale, and disseminated rolled fragments of lignite. This clay effervesces briskly in hydrochloric acid. A similar clay lies under this organic mass, considerably thicker than the upper clay. A short distance further down, into the deeper parts of the ravine, brings to the surface glacial boulders. This seems to me, therefore, to be a mass of organic matter collected in a low place in the glacial clay surface some time during the glacial period, probably toward the close. A fragment is sent with this as a specimen. The rootlets of living plants traceable in this specimen disappear further in the bank when the surface is cut away a few feet.

[Note.—This interesting observation of Prof. Bechdolt shows the wide extent of the peat deposit, which accumulated between

two epochs of glacial cold, in southern Minnesota. In eastern Freeborn and in Mower counties it has been found extended over an area of several townships, lying outside of the morainic belt that crosses this part of the state north and south, and yet separating two distinct glacial clay deposits.* In Blue Earth county it is here found on the opposite side of the same morainic belt, and within the area of the glacial activity of the last cold period. If the deposits at these two points were contemporaneous, it is necessary to find some explanation of the extension of till eastward, so as to cover it several miles beyond the supposed farthest limit of the moving ice, in Freeborn and Mower counties, and of the preservation of it from disruption by the ice in Blue Earth county while it prevailed over a great area, and extended into Iowa, as well as of its final burial beneath the six feet of pebbly clay which lies over it. If the deposits at those two points were not contemporaneous, but one succeeded the other by an interval of time amounting perhaps to several thousands of years, allowing the shrinkage of the ice mantle from its outer limit to one of the later stages of its retreat, it will only be necessary to find an explanation for one fact, namely: the extension of till outwardly for several miles beyond the so-called "terminal moraine." But it will be necessary also to suppose the long continuance of the same peat-forming conditions about the southern ice-margin.

If, on the other hand, the till which overlies the peat in Mower county be not the horizontal extension, and equivalent of that which overlies it in Blue Earth county, and there were no lateral extension of the till beyond the ice-margin as above presumed, then the two tills in Mower county, separated by this bed of peat, show the existence of two glacial epochs in Minnesota prior to that which has been described as *the last* glacial epoch, and the clay which covers the peat in Blue Earth county may be a pebbly clay of a semi-lacustrine origin — one of the incidents of the ice-retreat through the Undine region.†

A specimen of this ancient peat from Blue Earth county was sent to Mr. B. W. Thomas, of Chicago, for microscopic examination. He reports: "I send you slides of diatoms, sponge spiculæ, Radiolarius, etc., from the interglacial peat you so kindly sent me. So far as I have yet noted, all of the forms are fresh-water, about the same as those now found in your fresh-water ponds, streams, swamps, etc."— N. H. W.]

* Final report, vol. I, pp. 363 and 390.

† Final report, vol. I, p. 442.

Clays.—On Friday afternoon, October 17th, Mr. S. F. Alberger took me to see the place where he has obtained the pottery clay, containing the Cretaceous leaves. This point is about half way between Chalk run and the farm house on the Le Sueur river bank, and as to thickness, etc., of deposit, and over and underlying matter, are well described on pages 435 and 436, volume one, of the final report of the geological survey of Minnesota. In the cut whence come the fossil leaves, appears on one side a large boss of rock, whether connected with other rock or not within the bank, could not be determined. The part exposed was about four feet each way, is very much water-worn, seems on the surface formed of a white clay very firm and hard. Throughout this clay are scattered, very thickly, little rounded masses of the size of peas, quite distinct in form from the clay, but seeming to possess the same composition. Within, the rock is more siliceous; grains of free sand cover a freshly broken surface. Along the side of the rock mass are markedly seen the lines of stratification, exactly as seen on the water-worn or weathered surface of the Shakopee at the cement works and elsewhere. (See figure 11.)

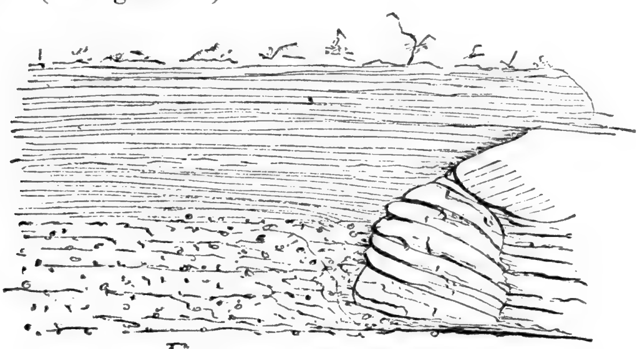

Fig. 11—Clays at Mankato.

A little further along the bluff toward Chalk run is an exposure of the Cretaceous clay, made during last winter. Here the clay rests on a floor of rock, whose edge is not exposed. This rock has the "fawn" color, hardness and general external properties of some of the softer layers of the Shakopee. It is worthy of note that the white clay on the Jordan sandstone is from twenty to thirty feet below this; and incidentally that from fragments of stone found in this white clay on the southeast corner of Chalk run bluff, where it is just now being uncovered for use this winter, the white clay seems to lie on eroded surfaces of the Jordan.

[NOTE.—The following observations were made at the pottery works of Mr. Alberger, in October, based on a quantity of material for use derived from his clay-pit a short distance above the bluff at the railroad crossing, the same point as above illustrated by Prof. Bechdolt. The clay here used contains numerous leaves, and through the kindness of Mr. Alberger a collection has been made and submitted to Dr. Leo Lesquereux, of Columbus, O., for determination. The relative position of the white clay and the other parts of the bluff is here determined by the statements of Mr. Alberger.

In the white (kaolinic) clay lying directly on the sandrock are small concretions of silica, about as large as pin-heads. They have a dull or dirty amethystine color, and are generally in definite horizons, or very thin sheets running coincident with a kind of structural fibre in the clay itself, though in general the clay is homogeneous and massive.

The white clay is sometimes concretionary—at least lumps of a coarsely concretionary, kaolinic, clay, resembling that seen under the Cretaceous at two miles below the Lower Sioux Agency*—are found in the bed which Mr. Alberger uses for tiling and fire brick. They probably appertain to the conglomerate, which is closely associated with the potter's clay at that place. When he screens the conglomerate, in order to get siliceous material for his fire-brick, these concretionary lumps are brought to light. Some pieces are small, like a hickory-nut, and some are as large as a peck measure. They are derived apparently, *en masse*, directly from the bed of decayed material lying on the crystalline rock-surface at the time of the Cretaceous submergence. The most of the white kaolinic clay, as it lies in, under and on the Shakopee and Jordan formations, is supposed to be due to the reassorting and distributing agency of that ocean on that preexisting mass of soft material; said mass being the result of weathering and decay of the crystallines through Silurian and Carboniferous times. In the same conglomerate are silicified corals and brachiopods of Silurian and even Devonian age, found as water-rounded pebbles. Mr. Alberger's tests seem to show that this conglomerate consists of purer silica, though containing some chert, etc., than the sandrock lying under the Shakopee limestone. The underlying sandrock, he says, will fuse in the heat he produces, rather easily, but the crushed pebbles of this conglomerate he cannot fuse.

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* See the second annual report, p. 187.

The following facts and observations were derived from a late visit to the cement works of the Standard Cement company, at Mankato.

1. They do not use the whole rock now, as they did at first, but only the lower ten feet (about ten feet).

2. They have had some poor cement, but this is now obviated by making some selection of the rock.

3. Mr. Bodé, chemist at Milwaukee, has analyzed all the strata, and given careful attention to the differences of composition, the strata being numbered from near the top downward. Nos. 3, 6 and 7 had nearly the same composition, but they are using all below No. 3.

4. The upper portion is burned for quicklime, or is sold at twenty-five cents per load for common building rock, the purchaser hauling it away.

5. The company have sold in advance all the cement they can make from this date to Jan. 1, 1885, and say they will continue in operation into the winter as late as possible, even if they "have to shed the quarry" — the product for the season being from 25 to 30 thousand barrels, at $1.50 per barrel.

6. The irony crust on the Shakopee is not so much due to the superposition of something new, by accretion, on the surface, as to a change in the Shakopee itself to the depth of about half an inch. The crystalline facets of the dolomitic rock can be seen plainly preserved within the irony crust at some distance from the line of transition from the rock to the crust. There is also a somewhat different color and texture in the lower part of the crust.

7. If the clay lying under the limerock is of the same age as the limerock (Cambrian), as supposed by Prof. Bechdolt, and as indicated by the appearances at the quarry, and by the intercalation of their clay beds within the beds of the limerock at higher levels, that seem to be of the same age as that below — I can only explain it on the hypothesis that the Shakopee lies unconformably, near here, on the crystallines, and that at the time of its deposition, a submergence like that which preceded the Cretaceous kaolinic clays, took place, thus bringing the older decayed material within the strata of the Cambrian. If that be the case the Shakopee will be found somewhere near Mankato lying on the crystalline rocks (though here it lies on the Jordan), and the white underlying clay will there be still thicker, though at remoter points the same clay is known to disappear wholly from this ho-

rizon. By a later (Cretaceous) submergence the same process took place again and gave Cretaceous kaolinic deposits, the result of wash from both crystalline and Cambrian areas. This whole hypothesis, however, as yet seems to me unnecessary, since I think all the clay within and under the Shakopee may be attributed to the insinuating action of the water of the Cretaceous ocean on the pre-existing weather-cracks and openings of the Shakopee, carrying the fine clay to the deepest recesses, wherever the water could enter — and especially because we know of no such overlapping of the later Cambrian unconformably on the crystallines.— N. H. W.]

XVIII.

FOSSIL ELEPHANT IN WINONA COUNTY.

BY PROF. JOHN HOLZINGER.

STATE NORMAL SCHOOL,
WINONA, Feb. 11, 1885.

Prof. N. H. Winchell, Minneapolis, Minn.,

DEAR SIR: If my memory serves me correctly, you inquired quite a while ago about some remains of a mastodon supposed to have been found in Winona county, and now deposited in our Normal School museum. I wrote to you then that we have only the remains of a mastodon found near Dubuque, Iowa. And this was in fact all that I knew at the time. Recently when I removed the precious remains of said animal I discovered the incongruity of the crown of a tooth, and a fragment of a tusk with the rest of the skeleton. Since then Prof. Morey, former principal of our school, has gone through the Museum with me, and when I indicated to him the want of agreement in the structure of the several parts, he informed me that the tooth and fragment of tusk did not belong to Prof. Woodman's collection* at all. These pieces, he said, were added during his administration; and he knew positively that they were found by the workmen on the Chicago & Northwestern railway, near Stockton, and that in the same locality was found a large antler of an elk, about three feet long. But the striking point of it all is that tooth and tusk seem to be not parts of a mastodon; but, to judge from the grinding surface, and size of the tooth, they belonged rather to a species of Elephas. The question is, was it the common Elephas primigenius.

Hoping that it is not too late for you to make use of this note, I remain, cordially yours, JOHN M. HOLZINGER.

* The Dubuque specimen had been purchased of Prof. H. T. Woodman.

[Note—On making further inquiries concerning the exact location of the finding of these remains, Prof. Holzinger ascertained, from Dr. Cole, of Winona, that he had brought a piece of a tusk from Stockton, taken from a clay-bank within forty rods of the railroad crossing of the highway, and deposited it in the Normal School museum, some twenty years ago. Also, that Hon. Thomas Simpson sent the greater part of the piece of tusk to the museum of the State Historical Society. Mr. Simpson also stated that the tooth now in the possession of the Normal School was found in the same place as the tusk, only a little later, during the cut through the clay-bank. This clay-bank is the loess-loam of the region, lying in the valley where Stockton is situated, between high rock-bluffs composed of the St. Croix and St. Lawrence formations.*

By the kindness of Prof. Holzinger this tooth was submitted for examination and description, and the following notes were made. It is illustrated by the figure on plate II.

It is not an entire tooth, but apparently less than one-half of the original. It is five inches long, fore and aft, on the crown, and three and a half inches in width. Entire plates are wanting from both ends, so that the piece, as shown in the figure, represents the central triturating surface of the crown, well worn. It is five and three-fourths inches deep perpendicularly, with signs of having lost an inch or more. The flat crown shows eight enamel plates (one at each end), the average distance between their centres being three-fourths of an inch. The thickness of these plates, though double, averages less than one-quarter of an inch; and hence the intervening cementum averages a little more than one-half inch in thickness. These plates are, therefore, "attenuated and concentrated," as Falconer remarks of American representatives of the Elephas primigenius. The plate represents the natural size of the crown of the tooth.

The dentine (in the centre of the plates) is so thin in some places as to be hardly visible. The enamel plates are direct and uncrimped, hardly undulating as they pass from one side of the tooth to the other. This might be *Elephas primigenius*, Blu., as that species was at first understood to range in America.

In 1838, Dr. C. Briggs, a member of the corps of the first geological survey of Ohio, first described Elephas Jacksoni, from Jackson county, Ohio, as distinct from E. primigenius, Blu.† and

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* See the final report, vol. 1, p. 238.

† Mather's first annual report, 1838. This name was first applied by Briggs in the American Journal of Science, vol. xxxiv, 1838.

Mr. Billings was disposed to have this name cover all specimens, except E. Columbi, "found in America as far north as the United States and Canada," (Canada then was Upper and Lower Canada, and not the Dominion, as now,) including that described by himself from Burlington Heights, near Hamilton, at the western extremity of lake Ontario, found in 1852.

De Kay, however, according to Leidy in "Extinct mammalian fauna" (vol. vi, of the second series of the Philadelphia Academy of Natural Sciences, Journal), named the American specimens E. americanus, a name which Leidy revives and continues, both in the above publication and in the volume of Hayden's survey (vol. i), entitled "Contributions on the extinct vertibrate fauna of the western territories," p. 238. Billings, however, attributes the origination of the specific name americanus Leidy, at the date of 1853. (See Can. Nat., vol. viii, p. 146.)

Dr. Falconer established E. columbi in 1857, concluding it ranges about the gulf of Mexico and southward. (Natural History Review, Jan., 1863.) He seems to include in it E. jacksoni, of Briggs, and its representatives from other places.

E. imperator, Leidy (1858), was at first thought to be new, because associated, as supposed, with a peculiar geological fauna of a different (earlier) age, but Leidy now rather includes it (with columbi) in americanus, and thinks its relations to the other fossils with which it was reported to be associated are not established satisfactorily.

E. texanus (Blake or Owen, 1858) is satisfactorily proved by Falconer to be a synonym of E. columbi. (Nat. History Review, Jan., 1863.)

Billings in the Canadian Naturalist, vol. viii, p. 146, regards columbi and jacksoni as distinct from each other, and from primigenius.

This Stockton specimen is quite distinct from the Montana specimens described in the tenth annual report, in the thinness of the plates, and the large amount of cementum between them; and if either be different from the primigenius, of Blumenbach, it is that from Stockton, and might be distinguished by Leidy's name americanus. According to Falconer, however, probably the best of English authorities, these would all be classed as primigenius.—N. H. W.]

XIX.

BOULDER-CLAYS.

ON THE MICROSCOPIC STRUCTURE OF CERTAIN BOULDER-CLAYS AND THE ORGANISMS CONTAINED IN THEM. BY DR. GEORGE M. DAWSON, D. S., F. G. S., F. R. S., CAN., ASSOCIATE R. S. M., AND ASSISTANT DIRECTOR OF THE GEOLOGICAL SURVEY OF CANADA. *

In a paper read before the Academy in January, 1884, and printed in the bulletin of the Academy (vol. i, No. 4), H. A. Johnson, M. D., and B. W. Thomas, F. R. M. S., gave the results of an investigation by them of microscopic organisms in the boulder clay of Chicago and vicinity. This paper refers principally to certain remarkable bodies first found by these gentlemen in 1865–6–7 in specimens of the clay through which the lake tunnel which supplies the city of Chicago with water from lake Michigan was being coustructed. On the completion of the tunnel large numbers of the same bodies were observed in the filtrate from the city water supply, and which were subsequently proved to be identical with organisms described in 1871 by Sir J. W. Dawson from the Devonian shales of Kettle Point, lake Huron. They have since been observed in the Devonian rocks of a number of widely separated localities, and are now believed by Sir J. W. Dawson to be the spores of rhizocarps.† Mr. Thomas, in a note to the paper first quoted, refers to the additional discovery in boulder-clay from Minnesota, sent to him by Prof. N. H. Winchell, of several species of Foraminifera, evidently derived from the Cretaceous rocks of that region. Since this announcement Mr. Thomas has mounted for the microscope and examined many samples of boulder-clays from various places, and has favored me from time to time with

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* Read before the Chicago Academy of Sciences June 9, 1885.

† Proc. A. A. A. S., 1883, and Can. "Record of Science," vol. i. See also paper by Mr. J. M. Clarke, American Journal of Science, vol. xxix, p. 284.

a number of his preparations. He has also kindly prepared and mounted specimens of several boulder-clays and allied materials collected in Manitoba and the Saskatchewan region. At his request the notes made by me on these last and on a few of those first mentioned are here offered. This paper must, however, be understood to be merely of a preliminary and general character, being based on the examination of less than one hundred microscopic preparations. It may, it is hoped, be supplemented later by a more detailed report, including the discussion of a larger suite of specimens from a greater number of localities.

The minute investigation of these boulder-clays has resulted in the discovery of many objects which, while evidently of organic origin, are very difficult to name or classify, and require comparison with a wide range of bodies and reference to many works for that purpose. Mr. Thomas has also found that even in the case of those clays with which he is most familiar each new lot of preparations mounted is almost sure to show forms not before observed, and that the field is an ever-widening one.

It is now, therefore, proposed merely to denote the classes of objects so far observed in the various boulder-clays, and when possible the genera to which the organisms belong, without attempting to catalogue them specifically. Neither is it here intended to enter into any further discussion as to the nature of the Sporangites occurring in some of the clays.

It should also be stated that most of the objects on the many slips examined have been indicated by maltwood markings by Mr. Thomas, a circumstance greatly reducing the amount of labor involved in going over the material.

[It should be explained that the material referred to in the succeeding notes is that part of the boulder-clay which is composed of particles of medium size, from which the very fine matter has, as a rule, been separated by decantation. This again has been sized by repeated decantations at intervals of one, two, or three minutes. Mr. Thomas states that the greater number of examples of a given form are frequently thus obtained in material of a certain grade of fineness.]

Boulder-clays of Chicago and vicinity.

The preparations examined representing the boulder-clay of Chicago and vicinity are as follows: From Chicago lake tunnel, 86 feet down, 5 slides; North Chicago boulder-clay, 60 feet down, 11; North Chicago clay, 64 feet down, 2; North Chicago, 65 feet

down, 10; corner of Washington and Clark streets, 8 feet down, 1; or 29 in all. These are so similar in their general characters and the class of objects which they present that they may be considered together.

The inorganic material in these clays, as represented by the above preparations, consists largely of quartz sand, in which few well-rounded grains appear, most being sub-angular and many quite angular and unworn. With these is about the usual proportion of bottle-green particles of hornblende, with a few of mica and feldspar. Nearly one-half of the entire material is, however, composed of flattened and rounded grains of fine shale, which have a dark brown color and granular texture by transmitted light. One or two of the quartz grains show included crystals and many hold fluid or gas cavities. The bodies of organic origin most commonly met with are referable to *Sporangites huronensis*, of Sir J. W. Dawson, of the Devonian shales. These are extremely abundant, and the shale particles already described are doubtless derived from the disintegration of the same beds. They are in some instances very well preserved, but are also present in all stages of decay, and in many cases hold a quantity of granular, shaly, or clayey matter in their interiors. Besides these a specimen occurs in the material from the lake tunnel of entirely different character. It is a partly flattened sphere of 0.2 m. m. in diameter, with radiating and concentric structure, brownish color, and very small central cavity, or nucleus. This is precisely similar to the bodies from the Devonian rocks described and figured as Macrospores by Mr. Clarke in his paper above referred to. Two more bodies of the same class appear in other preparations, but are more nearly transparent, and evidently in a different state of preservation. To one of them a small fragment of the matrix attaches and serves to show that both of these may have come from a limestone bed.

Next in abundance to the Sporangites is a class of bodies the true nature of which is very doubtful. Of these at least twelve large fragments were noted in the preparations under discussion, with many smaller and less characteristic pieces. They may be described as spines or spicules, generally cylindrical, but sometimes trough-shaped or triangular in cross-section, averaging about .05 m. m. in diameter, and of pale yellowish brown color. Their structure is very finely granular, and the outer surface more or less roughened, as though from erosion. They

are in some cases distinctly tubular, with a small central cavity; in others have a thick medullar portion, which is poorly defined but differs somewhat in texture from the exterior. Some of the fragments terminate in acute points, others have a slightly swollen, rounded end, and one was observed to be doubly terminated and nearly spindle shaped. They appear to be calcareous, but whether this is their original condition or the result of mineralization is uncertain. They can scarcely be chitinous, being much paler in color than other specimens of this character met with in some of the preparations. So many organisms may have produced spines or spicules resembling these bodies that it is not yet possible to assign them definitely. They do not appear to be sponge spicules, but as their color and texture is not unlike that of the next class of objects, they may possibly be partly mineralized chitinous setæ of Annelids, derived from some of the subjacent rocks. Their diversity in shape is such that they must either represent several species or belong to different parts of some organism in connection with which several types of appendage of this character are developed. See Fig. 12.

Among the most interesting bodies found in these clays are certain comblike objects which are regarded as annelid jaws. Of these four, all fragmentary, have been observed. They were at first supposed to be teeth from the lingual ribbon of some mollusk, but on more careful examination were found to be unlike the teeth of any mollusk of which figures can be found, and, moreover, to correspond almost exactly in form with some of the annelid jaws described by Mr. G. J. Hinde from the Silurian and Devonian rocks of Canada.* See Fig. 13.

One of the specimens shows a series of long and curved prongs. Three others apparently belong to a single type, in which a nearly flat plate is armed along one edge by a series of small, close denticles arranged somewhat obliquely to the line of attachment. See Fig. 14. Like the bodies last described they are of a pale straw color, differing in this respect from Mr. Hinde's specimens, which are said to be shining and black; but this difference may arise from the mode of preservation. They exhibit no reaction with polarized light, and are smooth and not distinctly granular. The ends of the prongs or denticles are worn and roughened as though by use.

Other bodies occurring in these preparations in smaller numbers need not be referred to in detail. Two broken specimens

* Quarterly Journal of the Geological Society, 1879, p. 370.

evidently represent Ostracoda. They show no well marked sculpture, but a minutely granular structure. The most perfect is .31 m. m. in length. A third specimen, somewhat larger, and also broken, is either a small Sphærium or a very young specimen of some larger shell. All three have adhering to them brownish shaly particles, which appear to indicate their origin, though it must be remarked that the shell substance is very well preserved and fresh looking. Still another specimen is a broken piece of the edge of a large calcareous shell or carapace, beautifully marked, and possibly that of an ostracod of another species. The remaining objects observed are mere fragments, quite indeterminate in character. Among these are small pieces of a delicate ribbed shell, the ribs being square in cross-section. A rather large chitinous fragment, striated extremely, but without any other apparent structure, and one or more pieces of straight tubular siliceous spicules, probably belonging to some sponge.

The probable sources of the organic bodies in these clays is discussed subsequently in connection with those from other places.

Boulder-clays from Bloomington, Ill., 107 *feet down.*

[This clay immediately underlies an interglacial deposit of soil and peaty matter with remains of wood, etc.]* Of this clay five preparations only have been examined. The coarse material is here chiefly quartz sand, of which by far the larger proportion is sub-angular. There are also a few grains of amethystine quartz, showing sharp conchoidal fracture. Several quartz grains show inclusions, one of verysmall hexagonal red crystals, probably hematite. Hornblende grains are moderately abundant, but shaly fragments such as those which make up a large proportion of the material from the Chicago clays are almost or altogether wanting. A few Sporangites exactly like those previously noticed occur, together with one or two specimens of the pale brownish granular spines, or setæ, found in the Chicago clays. A small, flat, curved, finely ribbed body in one of the slips resembles part of the edge of a carapace. While therefore not altogether wanting in this clay, organic traces appear to be very scantily represented.

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* This stratum of soil is about 6 feet thick, and underlies 101 feet of boulder-clay. I do not know the thickness of the clay deposit below the inter-glacial soil.— B. W. T.

Boulder-clays from Meeker county, Minnesota.

This material is derived from a well shaft sunk in Meeker county, at a depth of about twenty-two feet, and was transmitted to Mr. Thomas by Prof. N. H. Winchell, state geologist of Minnesota. Mr. Thomas has made a large series of preparations from it, a number of which I have had the opportunity of inspecting.

As the Foraminifera contained in these preparations are being named and catalogued by Messrs. A. Woodward and B. W. Thomas, the remarks here given are confined entirely to the general character and contents of the clay, with the object of comparing it with those from other localities.

The coarser material from this clay, as it appears in the preparations, is chiefly quartz sand, which is generally sub-angular, though with some well-rounded grains. Hornblende and mica appear in about the usual proportions, and two quartz grains with very beautiful inclusions were noticed, one being probably either hornblende or rutile, the other possibly apatite. A large proportion of the material, however, consists of rounded grains of shale, of gray or greenish-gray color by transmitted light, and not nearly so dark as the shale mixed with the Chicago clays. In specimens boiled in nitric acid, the shaly fragments have become reddish from the oxidation of the iron.

Of organic bodies present in these specimens of Minnesota clay, the Foraminifera are most prominent and important. They are evidently derived from the Cretaceous strata, and resemble those found in the western development of these rocks, both specifically and in mode of preservation.

Ratalidæ and *Textularidæ* are most abundant, though specimens of *Globigerina* and other genera also occur. Next in abundance to the Foraminifera are remains of Radiolaria. Some difficulty was experienced in deciding the true nature of fragments of these bodies at first met with, but the subsequent discovery of numerous and often well preserved specimens, and the observation by Mr. Thomas that they resist boiling in nitric acid, now leaves no doubt as to their character. Several genera and quite a number of species are represented, and it will eventually be possible to determine many of these forms specifically. Most appear to belong to the Polysphæridæ and Cystidæ of Haeckel's classification. The constant occurrence of these bodies with the Cretaceous Foraminifera in the Minnesota preparations and in those from

other places, with their absence from these materials not equally characterized by the Foraminifera, leaves little room to doubt the common origin of both. Among miscellaneous objects from the Minnesota clay may be mentioned a few fragments apparently identical with the minutely granular spines or setæ described as occurring in the Chicago clays; also two broken portions of stout siliceous spicules, about .026 m. m. in diameter, one smooth, the other tuberculated; both tubular, and probably belonging to some sponge. Lastly, a single specimen of a very curious body, of straggling and irregular form, composed of numerous expansions differing in shape and size and pretty uniformly pitted, but connected by narrow, smooth necks. As this is in one of the preparations which has been treated with acid, it must be siliceous. I can only suggest that it may be the siliceous cast of some foraminifer like *Aschemonella catenata* of Norman, the arenaceous test of which has been composed of calcareous particles which have left pitted impressions on the cast. Against this is the fact of its small size, it being about .2 m. m. only in greatest diameter.

Boulder-clay from Crete, Saline county, Nebraska.

This material, Mr. Thomas informs me, was obtained from a single small excavation. It was forwarded to Mr. Thomas by Prof. G. D. Swezey, and is described by him in a letter to Mr. Thomas as a blue clay underlying the loess. The inorganic matter in the preparations made from it consists largely of fine angular and sub-angular quartz grains, with a small proportion of green hornblende and much shale or earthy limestone in little particles which differ in color and texture. It is extremely rich in organic forms, chiefly Cretaceous Foraminifera, so much so that it seems probable that it is largely composed of the debris of the Niobrara division of that formation, and that a complete study of its contents would practically include that of all the forms occurring in the chalky limestone of that stage. The present notice of it must therefore be considered as of the most general and preliminary character only. Of this material a suite of thirty-one preparations has been examined, and in an enumeration of about one hundred of the best preserved forms nearly fifty per cent belong to the *Textularidæ*, the remainder being made up in nearly equal proportions of *Globigerinidæ*, *Ratalidæ*, miscellaneous Foraminifera of other families, and radiolarians, resembling, and in some cases

identical with, the Minnesota species. Fragments of calcareous prisms from the shell of Inoceramus and in the finer matter specimens of coccoliths and rhabdoliths also occur; all resembling in every respect similar bodies found in the Niobrara rocks of Nebraska and Manitoba.*

Many of the Foraminifera are completely filled with calcite, while others are still partially hollow, and yet others are filled partly with calcite and partly with black carbonaceous or bituminous matter. Of objects of an unusual character two may be specially referred to. A rod-like body about .2 m. m. in length, narrowed near the middle, though broken at one end, and marked by numerous pits in linear series. This may be a small spine from some echinoderm. Also a hollow conical tooth or spine, evidently that of a fish, also broken, but still .25 m. m. in length.

Boulder-clay from a well at Rosenfeld, Manitoba.

This material, sent to me under the name of "hard-pan," was obtained at a depth of 135 feet, in a well bored by the Canadian Pacific railroad company at Rosenfeld, Manitoba. It formed, mixed with gravel and boulders, a layer of eighteen feet in thickness, below the post-glacial alluvial deposits of the Red river valley and resting on a Silurian shale. As the well was bored with an ordinary percussion drill, it is possible that some matter from the alluvial deposits above referred to may have been mixed with the specimen of "hard-pan," but so far as examined these alluvial deposits do not hold any organic forms. Numerous small particles of steel from the edge of the drill occur in the six preparations representing this clay.

The inorganic constituents are coarse in texture, quartz grains, of which nearly one-half are perfectly rounded, as usual predominating. Bottle-green hornblende is moderately abundant, as are also fragments of feldspar and limestone, but shaly materials are almost altogether wanting. Bodies of organic origin are rather scarce, Foraminifera, however, being most common, and a Textularia of the type of T. globulosa is characteristic. A few Rotalidæ are also present, with broken chambers of other Foraminifera. The examination of a greater quantity of the material would doubtless lead to the discovery of all the ordinary Cretaceous types.

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*See a paper by the writer in the Canadian Naturalist, 1874.

Boulder-clay from the South Saskatchewan river ten miles east of the mouth of the Swift Current.

This and the two following localities in the Canadian northwest territory are represented by specimens collected by Mr. R. G. McConnell. The three localities lie between the 106th and 108th meridians, and represent a portion of the great drift-covered area of the northern plains. The material from this place is, as usual, largely siliceous, but there is a larger proportion than common of coarse, thoroughly-rounded quartz grains. Hornblende and other crystalline minerals from the Laurentian or Huronian are also present, and there is a notable quantity of amethystine quartz in angular fragments. Comminuted very fine-ground gray shale is moderately abundant. Bodies of organic origin are not frequent. In pretty carefully examining a series of six preparations, about ten only were met with. These are *Textulariæ* and rotaline Foramiuifera, with one very small *Globigerina*, and a couple of radiolarians; one very perfect, oval and .09 m. m. in longest diameter. (*Haliomma?*) A fragment was also found of bony substance, showing haversian canals and probably portion of a ganoid scale. There is also in these preparations a number of rounded and flattened grains, nearly transparent, though in some cases with a more opaque central spot, and surface minutely and regularly roughened. These were eventually determined by comparison to be fragments of some pearly shell, probably that of Unio, a form quite abundantly represented in the Cretaceous and Laramie rocks of the region. The appearance of an opaque nucleus in some examples appears to result from the non-penetration of the mounting medium to the centre of the larger grains.

Boulder-clay from ten miles north of the South Saskatchewan, east of Missouri Coteau, township 21, *range* 10, *west of* 3d *principal meridian.*

The material in six preparations from this clay differs from the last described only in the much greater quantity of comminuted shaly matter of a reddish-brown tint. Bodies of organic origin are here again scarce. No Foraminifera were found. Two or three broken pieces of minute rod-like pitted objects, very doubtfully referred to small spines of some Echinoderm, and evidently identical in character with that previously described from Saline county, Nebraska, were detected. Those occurring here are

about .015 m. m. in diameter. Another somewhat similar object is rather stouter and with a roughened surface without regular markings. A small broken piece of some chitinous test was also observed, but on the whole this material is very barren.

Boulder-clay from the South Saskatchewan, fifteen miles above the Elbow.

In the preparations from this clay — eighteen in number — the sandy material is much finer than in the two last. It is nearly half composed of shaly fragments of brown color, the quartz sand being also rather more angular than usual. It is richer in organic forms than either of the other specimens from the neighborhood of the South Saskatchewan. About half a dozen specimens of Foraminifera were recognized in the preparations, one being probably a small *Discorbina*, others *Textulariæ*, and broken chambers of *Globigerinæ*. These are not so well preserved as in some of the other clays, and in some cases the shell itself appears to have been removed, leaving only a rough cast in calcite. Radiolarians are here (so far as the examination of a small quantity of material can be accepted as conclusive) even more abundant than Foraminifera; spherical, oval and turbinate forms all being represented, and in some cases in such connection with fragments of the abundant shaly material as to leave no doubt as to their common origin with it. Small, partly-rounded prisms from the shell of *Inoceramus* are also present, together with a few pieces of straight hollow siliceous spicatæ, one specimen of a minutely granular spine or seta, with a distinct medullar portion like some previously noticed, and .026 m. m. in diameter, and one of a portion of a body like that previously referred with doubt to an Echinoderm spine.

In inquiring as to the derivation of the various organic bodies in the clays, it is necessary to consider the situation of each locality with reference to known areas of the older rocks from the disintegration of which they may have come. The Sporangites so abundant in the Chicago clays have been definitely traced to the shales of the Devonian age, and have doubtless been brought to their present position from outcrops to the northward in the Michigan peninsula. It has already been stated that the bodies supposed to be Annelid jaws may probably have been derived from the same beds, or from others of the Devonian or Silurian rocks of this part of the country. With regard to the remaining bodies no definite statement can at present be returned,

though there is every reason to believe that they might very well have come from the same rocks.

In the clays from Bloomington, in the centre of the state of Illinois, Sporangites are again the most characteristic bodies, though much less numerous in correspondence with the greater distance from the shale outcrops. A few other objects associated with these are not dissimilar to those in the Chicago clays.

Meeker county, from which the specimens of Minnesota boulder-clay were derived, is in the southern and central portion of the state, and is underlaid, according to Prof. N. H. Winchell's map, by rocks of the Cambo-Silurian period.* As might be anticipated from the absence of Devonian rocks both in this locality and the whole region to the north and northeast, Sporangites have not been observed in this clay. While the greater part at least of the organisms are evidently referable to the Cretaceous rocks, the locality lies to the northeast of the generally recognized edge of that formation. Prof. Winchell has, however, proved the existence of a number of outliers of Cretaceous beyond the main area occupied by these rocks, and it is probably from one of these, possibly not remote from the actual position of the clay, that the Foraminifera and Radiolariæ have come.

The clay from Crete, Saline county, Neb., is, as already observed, so rich in Cretaceous forms as to lead to the belief that it is largely composed of the debris of the chalky limestone of the Niobrara stage, and may rest upon or lie very near to the outcrop of these beds. I am not in a position to state whether the geology of the district bears out this conclusion. The map shows at least that Cretaceous rocks underlie this part of the state.

The material from Rosenfeld, Manitoba, shows a smaller number of forms, but these are equally characteristic of the Niobrara stage, the outcrop of which, though concealed by alluvial and other deposits, can not be many miles west of the position of the well, and also runs northward along the base of the Pembina escarpment, having been recognized at a point about fifty miles northwest of Rosenfeld on the Boyne river. ("Geology and Resources of the 49th Parallel," p. 78.) As there is little probability of the existence of any Cretaceous rocks directly north or to the northeastward of this place, the occurrence of Cretaceous

* Dr. Dawson here is slightly in error as to the rocks underlying Meeker county. So far as known they are the crystalline rocks of the Archæan, probably overlain by the shales of the Cretaceous.—N. H. W.

Foraminifera would tend to show that material derived from the northwest had been incorporated with the boulder-clay of this district.

The three localities near the South Saskatchewan may be treated of together in so far as the origin of their organic constituents is concerned. The general movement of the material composing the glacial deposits of the northern plains in a southwesterly direction has already been demonstrated (see "Quarterly Journal of the Geological Society, 1875," p. 605; "Report of progress of the geological survey of Canada, 1882–4," p. 139) and it would appear that the Cretaceous Foraminifera must also have been carried from the vicinity of the eastern Cretaceous outcrops at a great distance. It is true that the clays here rest on Cretaceous beds, but these are not as a rule calcareous, or such as to yield Foraminifera in the state of preservation of these found in the clays. The Niobrara limestones are not only unknown in the entire district from which the clays come, but their place appears to be taken in this region by the Belly river beds, which are arenaceous and argillaceous. Other organic fragments present in these clays may well have been derived from the Cretaceous or Lamarie beds of the immediate neighborhood.

In reviewing the general bearings of the microscopical examination of these boulder-clays, representing as they do a few points only, scattered over a wide area in the central portion of the continent, it would be unwise to endeavor to draw any very definite or too general conclusions. The field appears to be a promising one for future inquiry, and the present paper can be regarded only as in the restricted sense, preliminary. It would appear, however, that of all the organic bodies met with none can be assigned with certainty to the glacial period or era of deposition of the boulder-clay itself. The origin of most can be traced unequivocally to the older rocks, from which they have been derived, and incorporated with the boulder-clays. Of all the bodies enumerated the only ones which, on account of their presence in clays, holding otherwise different sets of forms, may possibly be of contemporaneous origin with them, are siliceous sponge (?) *spicules* and the peculiar spines or setæ several times referred to in the foregoing. To these may be possibly added the Astracoda from the Chicago clay. While it is therefore probable that the examination of these organic fragments will serve to throw additional light on the direction of transport of material during the Glacial period — a point of particular value

over the wide area of the plains, where the soft character of the rock precludes the test of direction of striation — it has so far failed to afford any certain information as to the actual conditions prevailing during that period. The negative evidence, reinforced by the fact that derived bodies have been perfectly preserved, so far as it goes, leads to a belief in the great scarcity of contemporary life. The occurrence of inter-glacial peats and the induration of wood and other vegetable matters in the boulder-clays of a number of widely separated localities in the west (see "Vegetable remains in drift deposits of the Northwest," by Prof. N. H. Winchell, Proc. A. A. S., 1875; "Report of Progress of the Geological survey of Canada, 1882–4," p. 144) prove, however, that life was not constantly absent, and it may therefore reasonably be anticipated that further search will eventually lead to the definition in the clays of at least such contemporary organisms as may have been derived from these inter-glacial deposits, and possibly of others strictly contemporaneous with the boulder-clays themselves. The well-rounded character of a considerable proportion of the sand in some of the specimens points to prolonged water action, but there is no means of deciding to what extent in each case previously rounded sand grains have been included in the clays. The comparatively unworn appearance of the majority of the Foraminifera and other delicate objects, on the contrary, indicate rather tranquil conditions of deposit, and negatives the occurrence in the case of these materials of any extensive differential motion in the substance of the clay itself, which would infallibly have destroyed these very fragile organisms. Mr. Hugh Miller, in a carefully marked out paper on "Boulder glaciation" ("Royal physical society, Edinburgh," vol. viii, p. 157), describes a fluxion structure in the Scottish till or boulder-clay, and notes instances of sand grains so shaped and striated as to represent microscopic glaciated boulders which he conceives to have been "slidden along and glaciated in these places in the clay." No confirmation of this observation is afforded by these clays. Though many grains of an elongated shape show what might at first be taken for such striation, it is apparent in almost every case on close examination that the lines are really structural and that the shape of the grains is here, as in ordinary sands, governed to a great extent by the pre-existing cleavage or jointage planes of the material of which they are composed.

The microscopical examination of these boulder-clays bears

out the conclusion arrived at from their microscopic character, that, while largely composed of far-traveled material, they invariably contain a considerable proportion of material of local, or proximately local, origin.

Fig. 12 (×260)


Fig. 13 (×260)


Fig. 14 (×260)

Organisms from the Chicago boulder-clays.

XX.

ON THE FORAMINIFERA OF THE BOULDER-CLAY, TAKEN FROM A WELL-SHAFT 22 FEET DEEP, MEEKER COUNTY, CENTRAL MINNESOTA.

BY A. WOODWARD AND B. W. THOMAS. (JULY 1, 1885.)

[NOTE.—In the course of Mr. Thomas' investigation of the rhizocarps of the Devonian shales found in the Chicago boulder-clay, several years ago, he made a request for samples of boulder-clay from Minnesota, for comparison. About that time Mr. Dickson, living a few miles southwest from Litchfield, in Meeker county, who was sinking a common well for domestic purposes, on his farm, had found numerous fragments of Cretaceous lignite in the blue till into which he was sinking his well. These pieces attracted attention, in the public press, as indications of "coal." Thereupon Mr. Dickson, through the agency of Attorney J. N. Cross, of Minneapolis, sent me a lot of it, accompanied by a fair sample of the boulder-clay itself. This boulder-clay contained not only other pieces of lignite, but many bits of shale such as has been referred to the Cretaceous formation whenever seen in similar circumstances anywhere in the state. These were sent to Mr. Thomas. Subsequently much more shale was obtained at the same place and forwarded to Mr. Thomas. The microscopic fossils that Mr. Thomas has thus brought to light, and which are described, named and illustrated in the following paper by Messrs. Woodward and Thomas, are therefore fossils of the Cretaceous formation, and are not indigenous to the boulder-clay itself. The paper might be entitled, correctly, *The foraminifera of the Cretaceous*, since these bits of shale can be referred, without any doubt, to the Cretaceous, which is known to underlie large areas of the till in that part of the state, and since similar fossils have been found in the Cretaceous shales, *in situ*, by Dr. G. M. Dawson, in the escarpment of Pembina mountain, in Manitoba, (*Canadian Naturalist*, new series, vol. vii, p. 252). Still later a quantity of Cretaceous shale, much more calcareous, and referable to the *Niobrara*, of Meek & Hayden, was obtained at Redstone, New Ulm, through Mr. B. Juni, and sent to Mr. Thomas for a similar examination.

Through the intelligent co-operation and zeal of Mr. Thomas, united with the labor and skill of Mr. Woodward, in examining and illustrating these objects, an entirely new field of research is opened up to the geologists of Minne-

sota. Mr. Thomas has mounted all these objects for microscopic study, and has marked most of the forms on the slides with Maltwood numbers, and Mr. Woodward has drawn up the paper, which sets forth the result of their joint labor. It is to be hoped that this field may be further searched, and that a full account may finally be given of the entire microscopic fauna of the Cretaceous.— N. H. WINCHELL.]

The main object of this paper is simply to give some idea of the various forms of foraminifera to be found in the boulder-clays of Minnesota. We do not pretend that it is by any means a monograph or a perfect and complete paper, for we think from what observations we have made, and the number of species found from comparatively one or two localities, that a much fuller and more extensive paper could be written. But it cannot be done in a limited time, and it will require material from a great many localities, and several years of labor.

As it is we have been very successful, far beyond our expectations, considering the small amount of material at hand, from which we have prepared a large number of slides, selecting about eighty for this investigation, and by using a one-fifth objective we have identified the following species:

Textularia globulosa, Ehrenberg. Common.
T — agglutinans, d'Orbigny. Not common.
T — turris, d'Orbigny. Rare.
Spiroplecta Americana, Ehrenberg. Rare.
Gaudryina pupoides, d'Orbigny. Quite rare.
Bulimina pupoides, d'Orbigny. Rare.
Bolivina punctata, d'Orbigny. Rare.
Uvigerina canariensis, d'Orbigny. Rare.
Globigerina bulloides, d'Orbigny. Quite rare.
G — cretacea, d'Orbigny. Common.
G — marginata, Reuss. Quite rare.
Lagena favoso-punctata, Brady. Common.
Orbulina universa, d'Orbigny. Very common.
Operculina complanata, Defrance, sp. Rare.
O — complanata, var.
granulosa, Leymerie. Rare.

The material washed from the boulder-clays is at least 95 per cent sand, and the shells being in most cases filled solid with foreign matter, generally calcite, cannot be separated from it by drying, and scattering over distilled water, as we do recent foraminifera. Consequently it requires much work, time and

patience to secure a few good specimens of these interesting fossils.

These we have endeavored to figure and describe, giving the synonyms, and when possible using the original descriptions.

Sub-Kingdom PROTOZOA.

Class RHIZOPODA.

Order *Reticularia.*

(Foraminifera.)

TEXTULARIDÆ.

Sub-Family I.—TEXTULARINÆ.

TEXTULARIA, Defrance.

Textularia globulosa, Ehrenberg.

(Plate III, figs. 1–5.)

Textularia globulosa, EHRENBERG. Abhand. Akad. Berlin. (1838) 1839. pl. iv.
Textularia globulosa, DAWSON, 1874. Can. Nat. vol. vii, p. 253, fig. a.
Textularia globulosa, SCHARDT, 1884. Etudes Geol. Sur. le Pays—D'Enhaut. Bull, Soc, Vaud., vol. xx, p. 74.

"*T.—globulosa*, testula microscopica superficie lævi, in adulta longiore quam lata, articulis globosis." (Ehrenberg. (1838) Abhand. Akad. Berlin, p. 135.)

T.—globulosa, microscopic test with a smooth surface, adult forms longer than wide, with spherical or globular chambers.

Locality. Meeker county, Minn.

The species being generally distributed throughout the west. Is quite common in the boulder-clays of central Minnesota, also in the Cretaceous of Nebraska and Dakota.

Textularia agglutinans, d'Orbigny.

(Plate III, figs. 6, 7.)

Textularia agglutinans, D'ORBIGNY, 1839, Foram. Cuba, p. 144, pl. i, figs. 17, 18, 32-34.

Textularia agglutinans, SEGUENZA 1862, Atti dell' Accad. Gisenia, vol. xviii, (ser. 2), p. 112, pl. ii, fig. 4.

Plecanium sturi, KARRER, 1864, Sitzungsb. d. k. Ak. Wiss. Wien, vol. l, p. 704, pl. i, fig. 1.

Textularia agglutinans, PARKER and JONES, 1865, Phil. Trans., vol. clv, p. 369, pl. xv, fig. 21.

Plecanium agglutinans, REUSS, 1869, Sitzungsb. d. k. Ak. Wiss. Wien, vol. lix, p. 452, pl. i, figs. 1, 2.

Textilaria agglutinans, MOEBIUS, 1880, Foram. von Mauritius, p. 93, pl. ix, figs. 1-8.

Textularia agglutinans, BRADY, 1884, Report Foram. H. M. S. Challenger. Zool., vol. ix, p. 363, pl. xliii, figs. 1-3, vars. figs. 4, 12.

Textularia. Testa elongato-conica, rugoso-agglutinate, alba, lateraliter convexiuscula; postice cuneata; loculis largis, ultimis convexis; apertura semi-lunari. d'Orbigny (Foram. Cuba, p. 144).

Test elongate, conical, rugose, agglutinous (from grains of sand) white, laterally convex, posteriorly cuneate, segments large, the last convex, aperture semi lunate.

Locality, Meeker county, Minn.

Textularia turris, d'Orbigny.

(Plate III, fig. 8.)

Textularia turris, d'ORBIGNY, 1840, Mem. Soc. Geol. France, vol. iv, p. 46, pl. iv, figs. 27, 28.

Textularia turris, PARKER and JONES, 1863, Ann., and Mag. Nat. Hist., ser. 3, vol. xi, p. 97.

Textularia turris, BRADY, 1884, Report on Foram. H. M. S. Challenger. Zool., vol. ix, p. 366, pl. xliv, figs. 4, 5.

"*Textularia turris* is round in transverse section, elongate, and tapering. It differs from *Textularia trochus* chiefly in its greater proportionate length and its rougher exterior, as well as in its frequent irregularity of contour." Brady (loc. cit).

Locality, Meeker county, Minn.

We have been able so far to find but one specimen, while it

appears to be comparatively common in the Cretaceous beds of France, Bohemia, England and Ireland.

SPIROPLECTA, Ehrenberg.

Spiroplecta americana, Ehrenberg.

(Plate III, fig. 9.)

Spiroplecta americana, EHREN., 1854, Mikrogeolgie, pl. xxxii, I. figs. 13, 14; II. fig. 25.

Spiroplecta americana, BRADY, 1884, Report on Foram. H. M. S. Challenger. Zool., vol. ix, p. 376, pl. xlv, fig. 24, a. b.

"The test is usually much compressed, and widens rapidly towards the distal end; the lateral edges are thin and slightly lobulated, the chambers somewhat inflated, and the septal lines correspondingly depressed on the exterior; the walls are thin and smooth." Brady (loc. cit).

Locality, Meeker county, Minn.

This species does not seem to be very widely distributed.

The specimens figured by Ehrenberg were from the Cretaceous beds of Missouri and Mississippi.*

GAUDRYINA, d'Orbigny.

Gaudryina pupoides, d'Orbigny.

(Plate III, fig. 10.)

Gaudryina pupoides, D'ORBIGNY, 1840, Mem. Soc. Geol. France, vol. iv, p. 44, pl. iv, figs. 22-24.

Gaudryina pupoides, Id., 1846, Foram. Foss. Vien., p. 197, pl. xxi, figs. 34-36.

Gaudryina subglabra, GUMBEL, 1868, Abh. d. k. bayer. Akad. Wiss., II. cl., vol. x, p. 602, pl. i, fig. 4.

Gaudryina pupoides, BRADY, 1884. Report on Foram. H. M. S. Challenger. Zool., vol. ix, p. 378, pl. xlvi, figs. 1-4.

"*Gaudryina pupoides* is an easily recognised species. Its dimorphous mode of growth is generally very apparent, and its variability is limited to such features as the number of segments, the relative length and breadth of the test, and the degree of lateral compression. In recent shells the walls are thin and calcareous, smooth externally, and almost invariably of a greyish hue; fossil specimens sometimes exhibit a slightly rough exterior. In form

*Brady. *Report on the Foraminifera, H. M. S. Challenger, p.* 376.

and position the aperture resembles that of the typical *Textulariæ*, but it is often surrounded by a raised lip or borden." Brady (loc. cit.).

Locality, Meeker county, Minn.

Bulimina pupoides, d'Orbigny.

(Plate III, fig. 11.)

Bulimina pupoides, D'ORBIGNY, 1846, For. Foss. Vien., p. 185, pl. xi, figs. 11, 12.

Bulimina pupoides, WILLIAMSON, 1858, Rec. For. Gt. Br., p. 62, pl. v, figs. 124, 125.

Bulimina presli, var. pupoides, PARKER and JONES, 1862, Introd. Foram., Appendix, p. 311.

Bulimina pupoides, TERRIGI, 1880, Atti dell' Accad. Pont., ann. xxxiii, p. 193, pl. ii, figs. 30-34.

Bulimina pupoides, BRADY, 1884, Report on Foram., H. M. S. Challenger. Zool., vol. ix, pp. 400, 401, pl. l, fig. 15, a. b.

Shell oblong; obtuse, especially at the inferior lateral surface; composed of numerous segments, arranged in an indistinct spiral, and exhibiting a tendency to form three oblique vertical rows; segments remarkably ventricose and prominent; the anterior one usually more oblong than the rest, from its anterior part not being embraced, as all the preceding ones, by the next segment. Septal plane convex; semilunar. Septal orifice single, placed near the umbilical border of the septal plane, and usually characterized by a curious obliquity at its inner part, owing to the two lips of the orifice not meeting at their umbilical extremities, but passing one behind the other. Texture hyaline; transparent; when examined, after being mounted in Canada balsam, through a high power, it is seen to be perforated by innumerable minute foramina. Williamson's *Recent Foraminifera Gt.,Br.* p. 62.

Locality, Meeker county, Minn.

Sub-Family 2.—BULIMINIÆ.

BOLIVINA, d'Orbigny.

Bolivina punctata, d'Orbigny.

(Plate III, fig. 12.)

Bolivina punctata, D'ORBIGNY, 1839, Foram. Amer. Merid., p. 61, pl. viii, figs. 10-12.

Bolivina antiqua, Id., 1846, Foram. Foss. Vien., p. 240, pl. xiv, figs. 11–13.
Grammostomum polystigma, EHRENBERG, 1854, Mikrogeologie, pl. xix, fig. 84.
Grammostomum caloglossa, EHRENBERG, Ibid. pl. xxv, figs. 17, 18.
Bolivina punctata, BRADY, 1864, Trans. Linn. Soc. Lond., vol. xxiv, p. 468, pl. xlviii, fig. 9, a, b.
Bulimina presli, var. (*Bolivina*) *punctata*, PARKER and JONES, 1865, Phil. Trans., vol. clv, p. 376, pl. xviii, fig. 74.
Bolivina elongata, HANTKA, 1875, Mittheil. Jahrb. d. k. ung. geol. Anstalt, vol. iv, p. 65, pl. vii, fig. 14.
Bolivina antiqua, TERRIGI, 1880, Atti dell' Acad. Pont., ann. xxxiii, p. 196, pl. ii, fig. 40.
Bolivina punctata, MOEBIUS, 1880, Foram von Mauritius, p. 94, pl. ix, figs. 9, 10.
Bolivina punctata, BRADY, 1884, Report on Foram. H.M.S. Challenger. Zool., vol. ix, p. 417, pl. lii, figs. 18, 19.

B. testa elongata, compressa, conica, antice obtusa, postice acuminatea, alba, punctata, lateraliter subcarinata; loculis numerosis, obliquis, undulatis, ultimo obtuso; apertura simplici. D'Orbigny (Foram. Amer. Merid., p. 63).

Test elongated, compressed, conical, obtuse, anteriorly, acuminated posteriorly, white, punctate, sub-carinate on sides, with numerous oblique undulate segments, the last obtuse, aperture simple.

Locality, Meeker county, Minn.

LAGENIDÆ.

Sub-Family 1.—LAGENINÆ.

LAGENA, Walker and Boys.

Lagena favosa-punctata, Brady.

(Plate IV, figs. 32, 33, 34, 38.)

Lagena favoso-punctata, BRADY, 1881, Quart. Journ. Mic. Sci., vol. xxi, N. S. p. 62.
Lagena favoso-punctata, BRADY, 1884, Report on Foram. H. M. S. Challenger. Zool., vol. ix, pl. lviii, fig. 35, pl. lix, fig. 4, pl. lxi, fig. 2.

"Test ecto-or ento-solenian, shape variable; surface areolated or reticulated, with a conspicuous orifice or perforation in the middle of each area or depression. Length $\frac{1}{75}$th inch (0.34 mm.) or less." Brady (loc. cit.)

Locality, Meeker county, Minn.

Sub-Family 3.—POLYMORPHININÆ.

UVIGERINA, d'Orbigny.

Uvigerina canariensis, d'Orbigny.

(Plate IV, fig. 37.)

"*Testæ pineiformes minusculæ*," SOLDANI, 1798, Testaceographia, vol. ii, p. 18, pl. iv, figs. E, F, G, H.

Uvigerina nodosa, var. B, D'ORBIGNY, 1826, Ann. Sci, Nat., vol. vii, p. 269, No. 3.

Uvigerina canariensis, Id. 1839, Foram. Canaries, p. 138, pl. i, figs. 25-27.

Uvigerina winula, D'ORBIGNY, 1846, For. Foss. Vien., p. 189, pl. xi, figs. 21, 22.

Uvigerina irregularis, BRADY, 1865, Nat. Hist. Trans. Northd. and Durham, vol. i, p. 100, pl. xii, fig. 5.

Uvigerina proboscidea, SCHWAGER, 1866, Novara-Exped., geol. Theil, vol. p. 250, pl. vii, fig. 96.

Uvigerina farinosa, HANTKEN, 1875, Mitheil. Jahrb. d. k. ung. geol. Anstalt, vol. iv, p. 62, pl. vii, fig. 6.

Uvigerina canariensis, BRADY, 1884. Report on Foram. H. M. S. Challenger. Zool., vol. ix, p. 573, pl. lxxiv, figs. 1-3.

U. testa oblongo-conica, punctata, albida; spira conica, anfractibus quinis minime convexis; loculis convexis, per quamque spiram trinis; apertura rotunda; siphone brevi. d'Orbigny. (Foraminifera Canaries, p. 138.)

Test oblong conical, punctate, whitish with a conical spire of five whorls slightly convex, segments convex, three to each whorl of the spire, aperture round, siphon short.

Locality, Meeker county, Minn.

GLOBIGERINIDÆ.

GLOBIGERINA, d'Orbigny.

Globigerina cretacea, d'Orbigny.

(Plate III, figs. 14-16. II, fig. 19.)

Globigerina cretacea, D'ORBIGNY, 1840, Mem Soc. Geol. France, vol. iv, p. 34, pl. iii, figs 12-14.

Globigerina foveolata (pars), EHRENBERG, 1854. Mikrogeologie, pl. xxiv, fig. 49.

Globigerina libani, EHRENBERG, Ibid., pl. xxv, fig. 30.

Planulina pachyderma, Id., Ibid., pl. xxv, fig. 31.

Rotalia pertusa, Id., Ibid., pl. xxiv, fig. 41.

Rotalia aspera, Id., Ibid., pl. xxvii, figs. 57, 58, pl. xxviii, fig. 42, pl. xxxi, fig. 44.

Rotalia globulosa, Id., Ibid., pl. xxvii, fig. 60, pl. xxviii, figs. 40, 41, pl. xxxi, figs, 40, 41, 43.

Rotalia densa, Id., Ibid., pl. xxvii, fig. 62.

Rotalia quaterna, Id., Ibid., pl. xxvii, fig. 53, pl. xxviii, fig. 34.

Rotalia rosa, Id., Ibid., pl. xxvii, fig. 54.

Rotalia pachyomphala, Id., Ibid., pl. xxvii, fig. 55.

Rotalia tracheotetras, Id., Ibid., pl. xxvii, fig. 35.

Rotalia perforata, Id., Ibid., pl. xxviii, fig. 36, pl. xxix, fig. 2.

Rotalia protacmœa, Id., Ibid., pl. xxviii, fig 37.

Rotalia laxa, Id., Ibid., pl. xxviii, fig 38, pl. xxix, fig. 1, pl. xxxi, fig 42.

Rotalia centralis, Id., Ibid., pl. xxviii, fig 39.

Globigerina cretacea, BRADY, 1879. Quart. Journ. Micr. Sci., vol. xix, N. S., p. 285.

Globigerina cretacea, BRADY, 1884. Report on Foram. H. M. S. Challenger. Zool., vol. ix, p. 596, pl. lxxxii. Fossil specimens, fig. 11, a -c.

"Test rotaliform, much compressed; superior face flattened or only slightly convex, inferior side depressed towards the centre and excavated at the umbilicus, periphery obtuse and lobulated; composed of about three tolerably distinct convolutions, the outer most consisting of from five to seven segments; segments relatively small, subglobular; apertures opening into an umbilical vestibule. Diameter, $\frac{1}{50}$th inch (0.5 mm.)" Brady (loc. cit.)

Locality, Meeker county, Minn.

This species is very abundant in the boulder-clays of Minnesota, but the specimens we examined were quite fragmentary; perfect examples rare.

Globigerina bulloides, d'Orbigny.

(Plate III, fig. 13.)

"*Polymorpha Tuberosa et Globulifera*," SOLDANI, 1791, Testaceographia, vol. i, pt. 2, p. 117, pl. cxxiii, figs. H, I, O, P.

Testæ tuberosæ, etc., Id., 1798. Ibid., vol. ii, p. 20, pl. vi, figs. dd., ee.

Globigerina bulloides, D'ORBIGNY, 1826, Ann. Sci. Nat., vol. vii, p. 277, No. 1.—Modeles, No. 17 (young), and No. 76.

Globigerina bulloides, Id., 1839, Foram. Amer. Merid., p. 37.

Globigerina bulloides, Id., 1839, Foram. Canaries, p. 132, pl. ii, figs 1-3, 28.

Globigerina hirsuta, Id., Ibid., p. 133, pl. ii, figs. 4-6.

Globigerina siphonifera, Id., 1839, Foram. Cuba, p. 95, pl. iv, figs. 15-18.

Globigerina bulloides, Id., 1846, For. Foss. Vien., p. 163, pl. ix, figs. 4-6.

Globigerina concinna, REUSS, 1849, Denkschr. d. k. Akad., Wiss. Wien., vol. i, p. 373, pl. xlvii, fig. 8.

Globigerina diplostoma, Id., Ibid., p. 373, pl. xlvii, figs. 9, 10.

Globigerina depressa, EHRENBERG, 1854, Mikrogeologie, pl. xix, fig. 92.

Globigerina foveolata (pars), Id., Ibid., pl. xxii, fig. 74.

Globigerina cretæ, EHRENBERG, 1854, Mikrogeologie, pl. xxvi., fig. 44; — pl. xxx, fig. 38.

Globigerina stellata, Id., Ibid., pl. xxvi, fig. 45.

Globigerina ternata, EHRENBERG, 1854, Mikrogeologie, pl. xxxv B., figs. 5, 6.

Planulina poroteras, Id., 1854, Ibid., pl. xx, II. fig. 16.

Planulina pertusa, Id., Ibid., pl. xxii, fig. 75.

Planulina stigma, Id., Ibid., pl. xxv, fig. 29.

Rotalia rudis, Id., Ibid., pl. xxiv, figs 35, 36.

Rotalia leptospira, Id., Ibid., pl. xxiv, fig. 39.

Rotalia senaria (pars), Id., Ibid., pl, xxiv, fig. 40.

Ptygostomum orphei, Id., Ibid., pl. xxxv, B, figs. 1, 2.

Phanerostomum atlanticum, Id., Ibid., pl. xxxv, B., figs. 3, 4.

Globigerina bulloides, KUBLER and ZUINGLI, 1866, Neujahrsblatt, v. d. Burgerbib. in Winterthur, pt. 2, p. 22, pl. iii, figs. 30, 31.

Globigerina taminensis, Id., Ibid., p. 24, pl. iii, fig. 26.

Globigerina bulloides, GUMBEL, 1868, Abh. d. k. bayer. Akad. d. Wiss., II. cl, vol. x, p. 661, pl. ii, fig. 106.

Globigerina alpigena (?), Id., Ibid., p. 661, pl. ii, fig. 107.

Globigerina eocæna, Id., Ibid., p. 662, pl. ii, fig. 109.

Planulina mauryana, EHRENBERG, 1873, Abhandl. d. k. Akad. Wiss. Berlin (1872), p. 388, pl. iii, fig. 1.

Planulina globigerina, Id., Ibid., p. 388, pl. iii, fig. 3.

Planulina megalopentas, Id., Ibid., p. 388, pl. iv, fig. 7.

Pylodexia platyletras, Id., Ibid., p. 388, pl. iii, fig. 14.

Aristerospira omphalotetras, Id., Ibid., p. 388, pl. iii, fig. 15.

Globigerina detrita, TERQUEM, 1875, Anim. sur la Plage de Dunkerque, fasc. i, p. 31, pl. iv, fig. 4, a-c.

Globigerina bulloides, TERQUEM, 1875, Anim. sur la Plage de Dunkerque, fasc. i, p. 31, pl. iv, fig. 5, a. b.

Globigerina bulloides, BRADY, 1879, Quart. Journ. Micr. Sci., vol. xix, N. S., p. 71.

Globigerina bulloides, BRADY, 1884, Report on Foram. H. M. S. Challenger. Zool., vol. ix, p. 593, pl. lxxix, figs. 3-7.

"Test spiral, subtrochoid; superior face convex, inferior more or less convex but with deeply sunken umbilicus, periphery rounded, lobulated; adult specimens composed of about seven globose segments, of which four form the outer convolution; the apertures of the individual chambers opening independently into the umbilical vestibule. Diameter, sometimes $\frac{1}{40}$th inch (0.63 mm.), but oftener much less." Brady (loc. cit).

Locality, Meeker county, Minn.

Globigerina marginata, Reuss.

(Plate IV, figs. 20 22.)

Rosalina marginata, REUSS, 1845, Verstein. bohm, Kreid, pt. i, p. 36, pl. xiii, fig. 47.

Rosalina marginata, JONES, 1853, Ann. and Mag. Nat. Hist., ser. 2, vol. xii, p. 241, pl. ix, fig. 7.

Rosalina marginata, REUSS, 1854, Denkschr. d. k. Akad. Wiss. Wien, vol. vii, p. 69, pl. xxvi, fig. 1.

Discorbina marginata, Id., 1854, Sitzungsb. d. k. Akad. Wiss. Wien, vol. lii, p. 12, No. 2.

Globigerina marginata, PARKER and JONES, 1865, Phil. Trans., vol. clv, p.367.

Rotalia marginata, GUMBEL, 1870, Sitzungsb. d. k. bayer. Akad. Wiss., vol. ii, pp. 283, 287.

Globigerina marginata, RUESS, 1874, Das Elbethalgebirge in Sachsen, 2ter Theil, p. 112, No. 2.

Globigerina marginata, BRADY, 1879, Quart. Journ. Micr. Sci., vol. xix, N. S., p. 74.

Globigerina marginata, BRADY, 1884, Report on Foram. H. M. S. Challenger. Zool., vol. ix, p. 597, wood cut, fig. 17.

"Test rotaliform, much compressed; superior face convex, inferior face also convex but with a sunken umbilical recess, peripheral edge thin or subcarinate; segments numerous, five or six in the last convolution, the outer margin of each segment exhibiting a well-marked narrow border; apertures opening into the umbilical vestibule. Surface of living specimens beset with spines. Diameter, $\frac{1}{50}$th to $\frac{1}{25}$th inch (0.5 to 1 mm)." Brady (loc. cit).

Locality, Meeker county, Minn.

This species we are in some doubt about, it resembles so closely in some respects *G-linnæana*, while in others *Pulvinulina menhardii*; but the weight of evidence is in favor of *G. marginata*. Reuss.

ORBULINA, d'Orbigny.

Orbulina universa, d'Orbigny.

(Plate IV, figs. 25-31.)

"*Polymorpha Sphærule vitreæ*," SOLDANI, 1791. Testaceographia, vol. i, pt. 2, p. 116, pl. cxix, figs. I-N.

Orbulina universa, D'ORBIGNY, 1839, Foram. Cuba, p. 3, pl. i, fig 1.

Orbulina universa, Id., 1839, Foram. Canaries, p. 122, pl, i, fig. 1.

Miliola (Monocystis) arcella EHRENBERG, 1854, Mikrogeologie, pl. xxx, fig. i.

Miliola sphærula, Id., Ibid., pl. xxxi, fig. 1, a. b. c.

Orbulina granulata, var. *atra*, COSTA, 1856, Atti dell' Accad. Pont., vol. vii, p. 116, pl. xi, fig. 2.

Orbulina granulata, var. *areolata*, Id., Ibid., p. 117, pl. xi, fig. 4.

Orbulina universa, Id., Ibid., p. 114, pl. xi, fig. 5.

Orbulina universa, WILLIAMSON, 1858, Rec. For. Gt. Br., p. 2, pl. 1, fig. 4.

Orbulina punctata, TERQUEM, 1862, Foram du Lias, 2*ieme* mem., p. 432, pl. v, fig. 5.

Globigerina (*Orbulina*) *universa*, OWEN, 1867, Journal Linn. Soc., Lond., vol. ix, Zool., p. 149, pl. v, fig. 1.

Globigerina (*Orbulina*) *continens*, Id., Ibid., figs. 3, 4.

Globigerina (*Orbulina*) *acerosa*, Id., Ibid., fig 2.

Orbulina universa, BRADY, 1859, Quart. Journ. Micr. Soc., vol. xix, N. S., p. 75.

Orbulina universa, Id., 1884, Report on Foram. H. M. S. Challenger, Zool., vol. ix, p. 608, pls. lxxviii, lxxxi, figs. 8-26, pl. lxxxii, fig. 1-3.

Generic character. Shell free, regular, spherical, hollow; perforated by innumerable very minute foramina, visible only under a high magnifying power, septal orifice single, small, situate at some point on the periphery of the shell; without any marginal projection; often invisible.*

Spec. char. Spherical; parietes minutely granular, of a pale, grayish-yellow hue. Texture finely arenaceous. Septal aperture small; normally round, but usually irregular, and sometimes entirely closed up by the inspissated gelatinous sarcode, so as to be invisible. Diam. $\frac{1}{50}$—$\frac{1}{80}$.*

Locality, Meeker county, Minn.

It is a very cosmopolitan species, being found very abundantly, both living and fossil.

Several of the specimens figured by us seem to be covered with minute spines, as heretofore spoken of by other writers.

NUMMULINIDÆ.

Sub-Family 3.—NUMMULITINÆ.

OPERCULINA, d'Orbigny.

Operculina complanata, Defrance, sp.

(Plate IV, fig. 35.)

"*Operculum mimum,*" PLANCUS, 1739, Conch. Min., p. 18, pl. iii, fig. 1, A. B. C.

Lenticulites complanata, DEFRANCE, 1822, Dict. Sci. Nat., vol. xxv. p. 453.

* Williamson's *Recent Foraminifera G. B.* 1857.

Lenticulites complanata, BASTEROT, 1825, Mem. Geol. Env. Bordeaux, pt. i, p. 18.
Operculina complanata, D'ORBIGNY, 1826, Ann. Sci. Nat., vol. vii, p. 281, pl. xiv, figs. 7-10, Modele, No. 80.
Operculina ammonea, LEYMERIE, 1846, Mem. Soc. Geol. France, ser. 2, vol. i, p. 359, pl. xiii, fig. 11, a. b.
Operculina complanata, RUTIMEYER, 1850, Schweizer Nummuliten—terrain, p. 108, pl. iv, fig. 56.
Operculina arabica, CARTER, 1853, Journ. Bombay Br. R. Asiatic Soc., vol. iv, p. 437, pl. xviii.
Operculina hardici, D'ARCHIAC and HAIME, 1853, Descr. Anim. Foss, du groupe nummulitique de l'Inde, p. 346, pl. xxxv, fig. 6, a. b. c.
Operculina complanata, PARKER and JONES, 1861, Ann., and Mag. Nat. Hist., ser. 3, vol. viii, p. 229.
Operculina studeri, KAUFMANN, 1867, Geol. Beschreib. des Pilatus, p. 151, pl. ix, figs. 1, 2.
Operculina marginata, Id., Ibid., p. 152, pl. ix, fig. 4.
Operculina complanata, MOEBIUS, 1880, Foram. von Mauritius, p. 104.
Operculina complanata, BRADY, 1884, Report on Foram. H. M. S. Challenger. Zool., vol. ix, p. 743, pl. cxii, figs. 3, 4, 5, 8.

Operculina complanata, var. granulosa, Leymerie.

(Plate II, fig. 36.)

Amphistegina fleuriausi, D'ORBIGNY, 1826, Ann. Sci. Nat., vol. vii, p. 304, No. 7 (name only), fide Reuss.
Operculina granulosa, LEYMERIE, 1846, Mem. Soc. Geol. France, ser. 2, vol. i, p. 359, pl. xiii, fig. 12, a. b.
Amphistegina fleuriausi, REUSS, 1861, Sitzungsb. d. k. Ak. Wiss. Wien, vol. xliv, p. 308, pl. i, figs. 10-12.
Operculina irregularis, REUSS, 1864, Deukschr. d. k. Acad. Wiss. Wien, vol. xxiii. p. 10, pl. i, figs. 17, 18.
Operculina granulata, GUMBEL, 1868, Abhandl. d. k. bayer. Akad. d. Wiss., II. cl., vol. x, p. 663, pl. ii, fig. 111, a. b.
Operculina var. granulosa, BRADY, 1884, Report on Foram. H. M. S. Challenger. Zool., vol. ix, p. 743, pl. cxii, figs. 6, 7, 9, 10.

As there seem to be some doubt and difference of opinion in regard to this species and variety, we will only undertake to give the generic description given by H. B. Brady.

The test of the typical *Operculina* is a thin complanate disk, composed of three or four broad convolutions, symmetrically arranged, and equally visible on both faces. The central portion of the disk is usually somewhat thicker than the outer whorls, and not unfrequently almost umbonate ; the earlier convolutions are more or less embracing, the later whorls evolute. The segments are usually very numerous, of gradually increasing size, and typically very short in the direction of growth, as compared

PLATE I.

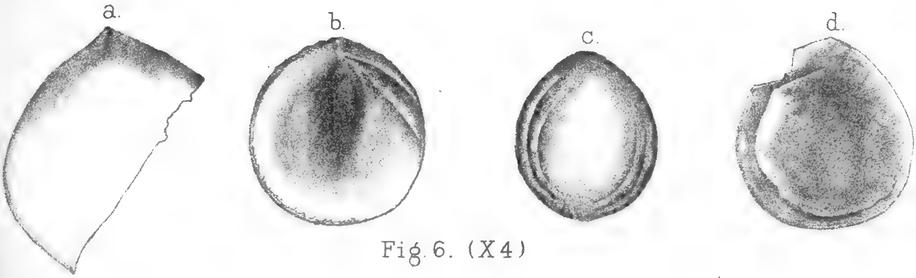


Fig. 6. (X4)

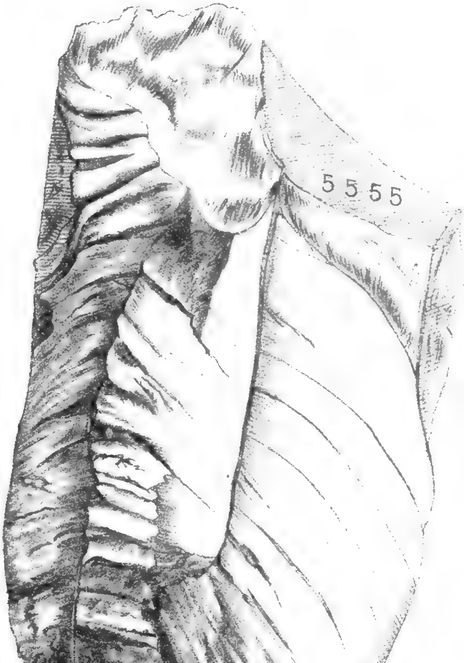
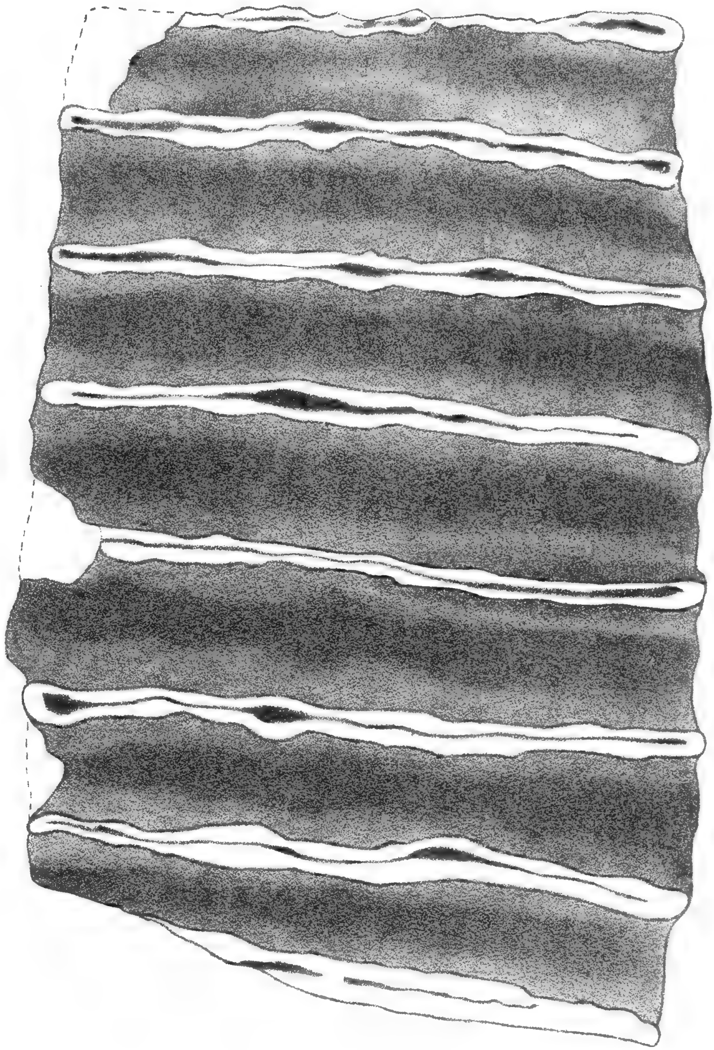


Fig. 7.

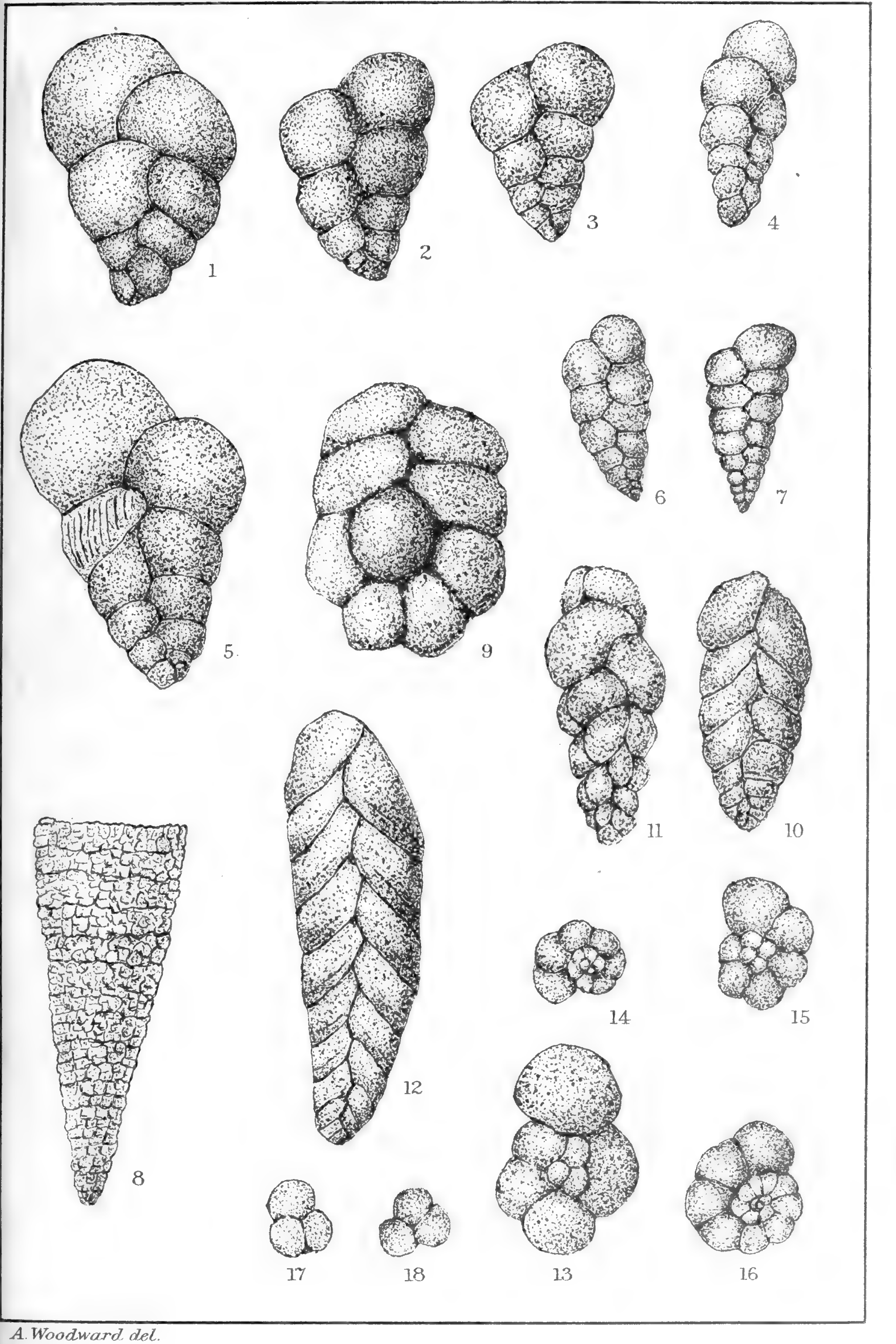
Julius Bien & Co. Lith.

PLATE II.



Julius Bien & Co. Lith.

PLATE III.



A. Woodward del.

PLATE IV.

		PAGE.
Figs. 19, 23, 24.	Globigerina cretacea, d'Orbigny	171
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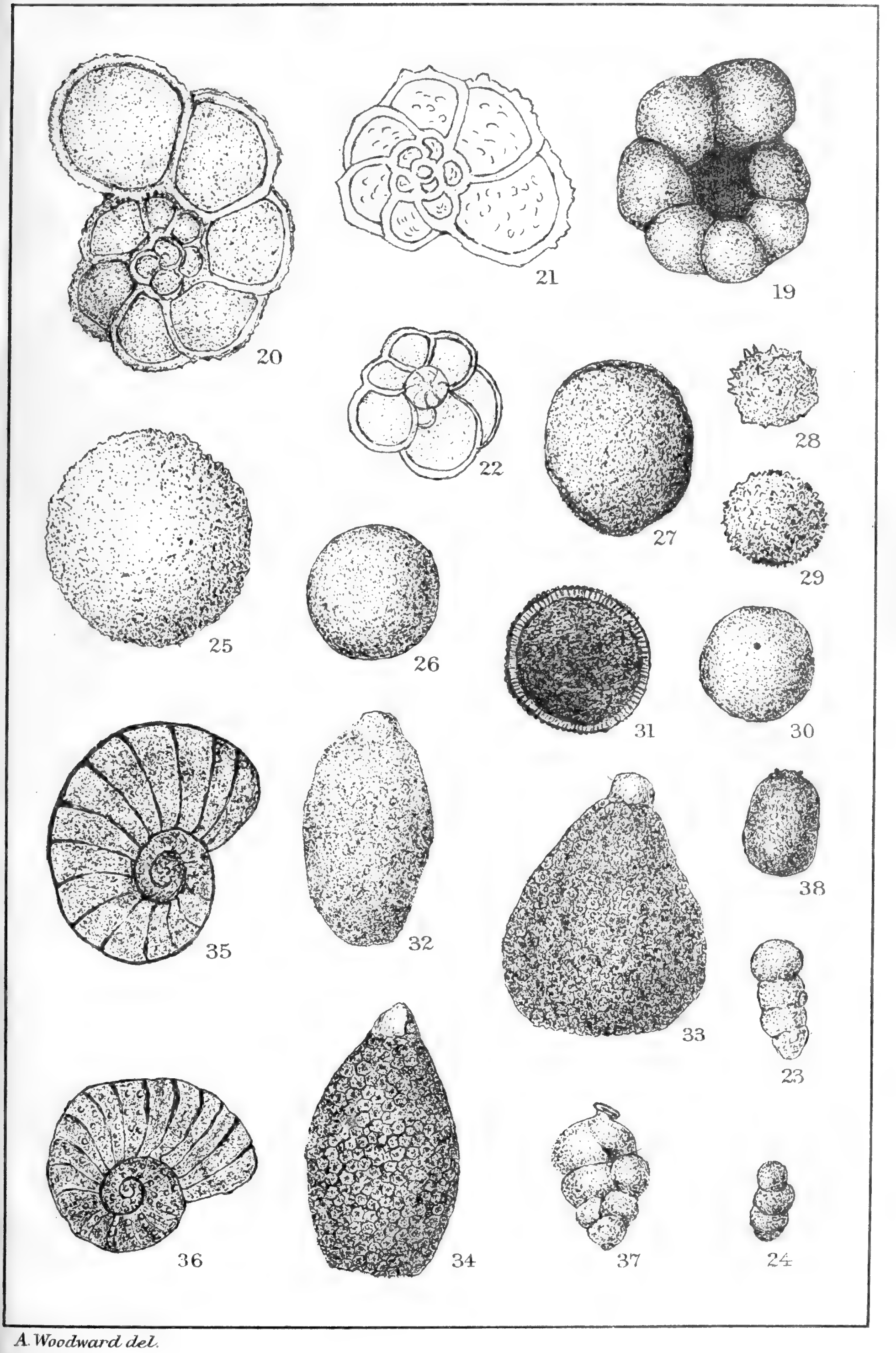

A. Woodward del.

with their width radially; they are for the most part produced on a uniform plan, but near the finish are often irregular, both as to shape and size (Pl. cxii, figs 3, 4 and 6). The exterior is sometimes smooth; but, more frequently, either the sutures or the surface of the chambers, or both, are ornamented with exogenous granules, papillæ or tubercles, which, as a rule, are more strongly developed near the centre than on the later whorls; and in the small, northern variety of the genus, the septal lines and periphery are distinctly limbate. The general aperture is a straight or slightly curved fissure at the inner margin of the final segment, close to the periphery of the previous convolution; but the test has frequently also a number of secondary orifices, in the form of small circular pores on the face of the terminal segment. The septa are double, and the skeleton is furnished with a system of canals, the general features of which are analogous to that of *Nummulites*.

Locality, Meeker county, Minn.

XXI.

NOTES ON THE MAMMALS OF BIG STONE LAKE AND VICINITY.

BY C. L. HERRICK.

The region about lakes Big Stone and Traverse is interesting not only from a geological standpoint but in its faunal relations. We here find the approximate limit of several distinct faunal areas and are not disappointed in expecting transitional forms and the material for deciding several interesting questions in systematic zoology. It is not the present purpose to anticipate the remarks which may be offered upon this subject in the final report on the *Mammals of Minnesota*, now approaching completion and which will be submitted in September, 1885; but it may be interesting to offer a few facts, which will hereafter be given more in detail, in order to secure, if possible, the co-operation of collectors in accumulating additional data. We shall find, then, in the immediate vicinity of Big Stone lake, species belonging strictly, first, to the plains of the far west, second, to the prairie region of the south and east, and third, to the woodland regions lying north and east. For example, we here find associated in seeming agreement such animals as the mole mouse of the plains, a variety of the common prairie *Vesperimus michiganensis* or Michigan mouse, the Sonora deer mouse (*Vesperimus sonoriensis*), the red-backed mouse (*Erotomys rutilus, gapperi*), the woodland *Zapus hudsonius* or jumping mouse, and, of late also, a few forerunners of the domestic mouse.

The following list embraces all the mammals at present known to inhabit the district in question, with such notes as seemed worthy of record at this time:

1. **Canis lupus,** L. Wolf.

2. **Canis latrans,** Say. Coyote.

3. **Vulpes vulgaris,** Flem. Fox.

4. **Putorius lutreolus,** Cuv. Mink.

5. **Taxidea americana,** Bd. Badger (?).

6. **Mephitis mephitica,** Shaw. Skunk.

7. **Lutra canadensis,** Sabine. Otter (?).

8. **Procyon lotor,** Storr Raccoon.

9. **Antilocapra americana,** Ord. Pronged-horned antelope.

The last occurrence of the antelope on the Minnesota side, of which I could learn, was in 1881, when one was shot six miles north of Brown's Valley, Traverse county.

10. **Vespertilio subulatus,** Say. Brown bat.

In passing over the many granitic and gneissic masses which shoulder their way through the surrounding drift in the immediate valley of the Minnesota river a few miles below Ortonville, the ear is constantly filled with an uneasy clatter, shrill and tormenting in the extreme, and proceeding from numberless bats passing the day in the crevices. It is not often easy to secure specimens, for, even if the hammer dislodges fragments of rock and destroy the retreat, the inhabitants take flight at once even in bright sunshine.

11. **Scalops argentatus,** Aud. & Bach. Prairie mole (?).

12. **Sorex (cooperi,** Baird ?). Western shrew.

Shrews, which in the lack of a special study are referred to this species, are very abundant at Brown's Valley, and in winter are said to become in part domesticated, living about barns and out buildings, much as the domestic mouse (which is not yet found here) does in other places.

13. **Sciurus hudsonius,** Pallas. Red squirrel (?).

14. **Tamias striatus,** L. Chipmunk.

The ground squirrel occurs in the thickets along the lakes, but is not abundant.

15. **Spermophilus tridecemlineatus,** Mitch.

The striped gopher is excessively abundant and in some seasons causes great havoc in the wheat as well as corn fields. It dwells on the prairie, while the next is equally abundant whereever a denser growth of grass or trees furnishes it a suitable retreat.

16. **Spermophilus franklini,** Sab. Gray gopher.

This species was found in greater abundance near Brown's Valley than elsewhere in Minnesota. It is entirely without fear and will take a place at the camper's table if unmolested, partaking of fish or fowl with no manner of diffidence.

17. **Geomys bursarius,** Shaw. Pouched gopher.

Our most earnest endeavors have failed in securing a specimen of *Thomomys* in Minnesota, although we had reason to expect its occurrence. The Geomys of Brown's Valley and Moorhead are typically the above species.

18. **Zapus hudsonius,** Zim. Jumping mouse.

It was with considerable surprise that the first specimen of this species as yet seen in Minnesota was captured at Brown's Valley in an oasis of the prairie region. The specimen was so unsuspecting that it was easily taken with the bare hand, and must have long lived in undisturbed quiet on the shores of lake Traverse.

19. **Mus musculus,** L. Domestic mouse.

A few specimens of a very yellow mouse, otherwise resembling the common mouse, were taken on the shores of Big Stone lake.

20. **Vesperimus sonoriensis,** Le Conte.

With some degree of surprise all the deer mice of the region in question were found to be in size and (less distinctively) coloration identical with the Sonora mouse. Of a considerable series not one has a tail over 2.60 inches, or a hind foot over .87, while the prevailing measurement of the former is 2.40, and of the latter .70. The colors are lighter and less conspicuous than in the deer mouse, and the white parts encroach more upon the

dorsal area, while the brown portion of the tail is a narrow stripe only. Besides these differences, in the whole anterior portion the pelage is sifted over with whitish, giving it a grayish tinge.

21. Vesperimus michiganensis, Aud. & Bach.

This species, which in the eastern part of the state is not abundant, is the most common form along the upper course of the Minnesota river. It appears in a gray, almost varietal, phase quite different in appearance from the eastern examples of the same species.

22. Onychomys leucogaster, var. **pallidus,** var. n.

A variety of the mole mouse hitherto undescribed is fully treated in the note at the close of this paper.

23. Erotomys rutilus var. **gapperi,** Vigors.

The red-backed mouse is by no means rare in the copses about the lakes and along the Minnesota river.

[24-25. Both *Arvicola austerus*, Le C., and *Synaptomys cooperi*, Bd., must be found in the region mentioned, or not far from it, but no examples have as yet been found in Minnesota.]

26. Fiber zibethicus, L. Muskrat.

The musquash is nowhere more common than in the prairie pools of the southwest. Were the fur of more than a nominal value the trapper would find profitable employment here. Upon the banks of the Minnesota river well beaten trails show where the animals leave the muddy banks where their dens are made, for the swamps adjacent.

27. Lepus sylvaticus, Bach. Gray rabbit.

This species is excessively abundant in the low ground along the upper Minnesota.

28. Lepus campestris, Bach. Prairie hare.

Quite common in winter, but it is seldom seen in summer. Universally called "jack rabbit."

To the above list which is necessarily only fragmentary, is appended a detailed description of *Onychomys pallidus*.

Genus Onychomys, Baird.

MOLE MICE.

This genus is of particular interest inasmuch as it contains three varieties of mice which, from their inaccessable station and secluded habits have seldom gained admittance to natural history museums, or received the attention of naturalists. This interest is enhanced by the fact that the genus is evidently very closely allied to *Vesperimus* but has developed in a direction entirely different from that group; and its species, externally and in habits, vary greatly from the deer mice. Fossorial prairie or desert animals living largely on insects might be expected to differ greatly from such saltatorial and gramnivorous animals as *Vesperimus* contains.

The mole mice are distinguished from their relatives by the compact arvicoline form, short tail and hind legs, well developed anterior extremities with fossorial claws, and the soft, mole-like character of the pelage. The hasty observer would refer the animal to *Arvicolinæ* rather than to the sigmodont *Murinæ;* indeed Prince Maximilian, who was the first to meet the genus, referred the *O. leucogaster* to *Hypudæus.* As we have specimens of none of the genus except *O. leucogaster*, var. *pallidus*, the reader is referred to the discussion of that variety for a description of the anatomical peculiarities. It seems that in view of the many points of divergence in structure and habits, there should be no hesitation in separating the mole mice generically from the *Hesperomys.*

Onychomys leucogaster, Maximilian. Missouri Mole mouse.

Hypudæus leucogaster, MAXIMILIAN, Reise in das Innere Nord America, 1841.
Mus missouriensis, AUDUBON and BACHMAN, Quad. N. A., 1851.
Hesperomys (*Onychomys*) *leucogaster*, BAIRD, Mam. N. A., 1857.
COUES, Proc. Acad. N. S. Phila., 1874; Monogr. N. A. Rodentia, 1877.
Hesperomys leucogaster, MAXIMILIAN, Arch. f. Naturg. xviii, 1862.

The single species thus far found under the genus *Onychomys* has differentiated into three more or less distinct geographical races or varieties. Of these but one is found in Minnesota, and that only upon the western boundary and a very short distance east of it.

The typical form is stated to be restricted to the upper Missouri river region, and is described as follows:

"Color above, grayish-brown, passing into yellowish-red, and

finally into a stripe of fulvous on the sides. Feet, including outer surface of the fore-arm and under surface of the body and tail, white."—*Baird.*

"Beneath, snow-white; above, mouse-brown, with darker dorsal area. Tail twice the hind foot or less; much less than half the head and body. Fore foot more than half the hind foot. Ear about .50 high."—*Coues.*

"The chief distinguishing feature in coloration, as compared with *Hesperomys leucopus*, is the mostly white muzzle."—*Coues.*

The following measurements from No. 7,492, of the National Museum, are selected as fairly illustrating the proportions. Nose to tail, 4.25; tail, 1.65; hind foot, .88; fore foot, .50; nose to eye, .60; nose to ear, 1.00; ear, .50. The skull of a somewhat smaller specimen measured 1.07 (Coues).

Onychomys leucogaster, var. **torridus,** Coues,

Was founded upon a single alcoholic specimen from Arizona, which differs in having rather larger ears and tail, and smaller fore feet. The colors are warmer. The following is Dr. Coues' diagnosis:

"Beneath, tawny-white (?); above, brownish-fulvous, with no darker dorsal area. Tail about two and a half times the hind foot; almost half as long as head and body. Fore foot half the hind foot. Ear about .75 high."—*Coues.*

Without discussing the characters on which this variety is founded, we may remark that in the only form which we have seen the proportional length of the tail and limbs was found to be subject to considerable variation, and that even while the exact pattern of coloration was maintained. Coues gives the following measurements of the specimen described: "Nose to tail, 3.75; tail, 2.00; hind foot, .80; fore foot, .40; nose to eye, .50; nose to ear, .95; ear, .70.

Onychomys leucogaster, var. **pallidus,** var. n.

This variety is based upon a series collected near the sources of the Minnesota river and the Bois des Sioux river in Dakota, which differs so completely in coloration from either of the above varieties as to be entirely incompatible with any description as yet given of O. leucogaster; while, at the same time, preserving the essential characters of the species. Upon first encountering the form while encamped on the shores of lake Traverse, the

writer was at a loss to classify his find, for, in coloration and form, it entirely differed from any description or figure known to him. It was at once set down as an Arvicola on the strength of its compact, obtuse form and burrowing habit, although the large ears and a certain vague suggestion in the appearance, hinted at *Hesperomys*. It was necessary to examine the teeth before conviction was reached that we had to do with a hesperomoid type. The mole-like appearance and habit at last furnished memory with the clue, and we recognized our capture as *Onychomys*.

It will be most satisfactory to transcribe the description made in our diary from the recently killed specimen as being quite unprejudiced by thought of comparison with other species.

Description of No. 103, collected July 4, 1885.

"Color nowhere other than black and white or a mixture of the two. Base of fur everywhere ashy gray. Above, black and white most intimately mixed so as to produce the effect of a whitish reflection from black fur, thus resembling a mole. On the sides the white tips are more numerous among the hairs so that the color is lighter, but the fur is so fine that the pelage would not be called grizzled. Under parts very pure delicate white (soft looking) but sparsely sown with the black-tipped hairs. Soles hairy. Tail not distinctly bi-color."

There is a dark ring about the eyes, the white of the lower parts embraces the lips to the nostrils and the muzzle is hoary. The lip is cleft and the fur about this cleft is long and hangs over like a moustache. The fur is close and dense about the small nasal pads. The insides and veins of the ears are silvery white.

The tail is terete and very closely hairy except at the tip which is as naked as in *Geomys*, and is gradually reduced in size from the middle to the apex. The vibrissæ are unusually fine and long, reaching beyond the apex of the ear and are of uncertain color, really black, but so polished as to appear partly white. The sole is very densely covered with fine close hairs, and there are but four tubercles. The ears vary in length, but seem to be intermediate between the varieties above mentioned.

O. pallidus burrows on the sandy prairies and seems to be largely diurnal in habit. We know little regarding its habits, but, inasmuch as its stomach was found filled with the remains of grasshoppers and other insects, we are justified in claiming that the suggestion of a largely insectiorous diet offered by the dentition is borne out by actual observation. The coloration

must be influenced by the constant exposure which a chase of diurnal insects makes necessary upon the open plains; and the short and nearly naked tail are suggestive of the fossorial habits.

The following table gives all the details at command concerning the proportions; and, as all the measurements were made with great care upon recently killed specimens, may be trusted as thoroughly reliable.

No.	Nose to anus.	Tail.	Nose to ear.	Nose to eye.	Hind foot.	Fore foot.	Ear.	Sex.
103	4.60	1.45	1.08	.60	.90	.55	.60	female.
104	4.40	1.35	1.00	.55	.90	....	.50	male.
105	3.95	1.50	1.00	.50	.80	.40	....	male.
114	4.15	1.60	.92	.50	.85	....	....	male.
115	5.10	1.60	1.20	.60	.90	.50	....	male.

Osteology of Onychomys pallidus. (No. 105.)

We shall present our material in the form of a comparison of the skeleton with that of *V. leucopus* as the most typical and readily obtainable example of *Vesperimus*. While much resembling that of *V. leucopus*, the skull is heavier and less slender. The facial portion, particularly, is shorter and blunter. The cranial portion is more capacious and shows a greater development of the parietals. Greatest length, 1.40; width, .58; width across parietals, .53; length of nasals, .37; frontals, .31; parietals, .18. The nasals project less beyond the incisors. The prepalatine foramen is much wider than in *V. leucopus*. The molars are larger than in any *Vesperimus*, although the third pair are more diminutive than in the actually smaller *V. leucopus*. The teeth are peculiar, especially for their very sharp-pointed angular prominences, which project out far from the crown of the tooth. The pattern is the same, but the appearance presented is very different. The basis cranii is broader, while the proportion of the parts is otherwise scarcely different. Length of basi-occipital, .16; molar series, 17; width of foramen magnum, .20. The lower jaw is chiefly remarkable for the great development of the coronoid process, which in *Vesperimus* is a minute hook, but here is large and strongly curved, extending nearly as far backward as the condyloid. The angle of the mandible is as in *Vesperimus*.

There are seven cervical, thirteen dorsal, six lumbar, three

sacral, and seventeen caudal vertebræ—forty-six in all. The caudal series measures 1.75, the sacral .36, the lumbar .70, and the dorsal about .90. The scapula is larger in proportion, in harmony with the greater development of the arm in general, but has the same form. Length, .54; width, .26. The humerus is .55 long, and is proportionately much heavier than in *Vesperimus*, but the superiority is more clearly seen in the forearm. The radius is .53 long, while the olecranon process of the ulnar is unusually strong. A general heaviness characterizes the bones of the hand. The hind limb is remarkable for the heavy and short bones composing it. The femur is .70 long, the tibia .75, and the longest metatarsal .30, while in *V. leucopus* these parts measure .60, .80 and .35. In this species only .30 of the fibula is united with the tibia, while in *V. leucopus* nearly .40 of its length is fused. We find, therefore, only a circumstantial confirmation of the view gained by external examination.

NOTE.—Measurements all in inches and decimals.

ERRATA FOR THE GEOLOGICAL REPORT.

Page 66, fifth line from bottom, for *two* read *four*.
Page 71, the first line should be transferred to the bottom of the page.
Page 149, fourteenth line, before *Leidy* insert *to*.
Page 171, seventh line from the bottom, for II read IV.
Page 176, twenty-first line, for II read IV.

INDEX OF THE GEOLOGICAL REPORT.

A

B

M

THE

GEOLOGICAL

AND

NATURAL HISTORY SURVEY

OF

MINNESOTA.

THE FOURTEENTH ANNUAL REPORT

FOR THE YEAR 1885.

N. H. WINCHELL, State Geologist.

Submitted to the President of the University, March 1st, 1886.

ST. PAUL:
J. W. CUNNINGHAM & CO.,
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ADDRESS.

THE UNIVERSITY OF MINNESOTA,
MINNEAPOLIS, MINN., MARCH 1, 1886.

To the President of the University:

DEAR SIR:—The fourteenth annual report of progress of the geological and natural history survey of the state is hereby presented.

I have the honor to be, very respectfully,

Your obedient servant,

N. H. WINCHELL,

State geologist and curator of the general museum.

THE BOARD OF REGENTS

OF THE

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REPORT.

SUMMARY STATEMENT.

The Legislature of 1885, not only made provision for the binding of the rest of the edition of vol. i., of the final report, but enacted a general law respecting the publication of other volumes. It reads as follows:

An act relating to the publication of the report of the geological and natural history survey of the state.

Be it enacted by the Legislature of the State of Minnesota:

Section 1. The governor, the secretary of state and the state geologist are hereby created a commission for the printing and publication of the reports of the regents of the university on the geological and natural history survey of the state.

Sec. 2. It shall be their duty to supervise the printing of the final reports of said survey, and the engraving of the accompanying maps and illustrations, in such style and manner as they shall determine and judge best calculated to exhibit to the people of the state, the natural resources of the state as required by the law creating the geological and natural history survey.

Sec. 3. They shall cause to be republished in the same manner the third (3rd,) fourth (4th) and fifth (5th) reports of progress of said survey, at as early a date as practicable, in an edition of two thousand copies.

Sec. 4. The volumes of the final report of said survey, as they may be prepared by the state geologist from time to time, shall be issued in an edition of five thousand (5,000) copies each, and shall be distributed, in the name of the board of

regents of the university, under the direction of the state geologist, to scientific and educational institutions, and to individuals, as follows: To the library of each chartered college and scientific institution in Minnesota, three (3) copies each; to each normal school, three (3) copies; to the libraries of the institute for the deaf and mute, the insane asylums, the state prison, and every public library in the state not otherwise designated, one (1) copy each; to each of the offices in the capitol, one (1) copy; to each member of the board of regents, three (3) copies; to the library of the state university, two hundred (200) copies; to the Historical Society, and to the Minnesota academy of sciences, ten (10) copies each; to each newspaper published in the state, one (1) copy; to each senator and representative of the present legislature, one (1) copy; to the governor and lieutenant governor, each one (1) copy; to each assistant on the survey who has furnished manuscript or illustrations published in the report, three (3) copies; to the general office of each railroad that has furnished aid to the survey, three copies; to the library of each high school, furnishing students fitted for the freshman class of the state university, one (1) copy; to the state library of each state in the Union, one (1) copy; to each state university and each college of agriculture and mechanic arts, one (1) copy; to geologists and naturalists of Minnesota, fifty (50) copies; to the geologists and naturalists of other states, two hundred (200) copies; to other colleges and scientific institutions in the Uuited States, one hundred (100) copies; to foreign institutions and scientists, one hundred (100) copies; and to the state geologist, twenty-five (25) copies. The remainder shall be deposited in the state university, and shall be sold at such prices as the board of regents may determine, and the proceeds of such sales shall be used by said regents for the purchase of apparatus and books for the survey, and after its completion, for the departments of natural science at the state university.

Sec. 5. The expense of printing, engraving, binding and distribution of said reports shall be paid out of anv moneys not otherwise appropriated, in the state treasury, on warrants of the state auditor approved by the governor and secretary of state.

Sec. 6. The commissioners hereby appointed shall perform the duties herein designated without further compensation than the payment of the actual expenses incurred in the discharge thereof.

Sec. 7. This act shall take effect and be in force from and after its passage.

Approved March 7, 1885.

The Legislature of 1885 also passed the following law transferring to the board of regents, for the survey, the indemnity lands granted by Congress.

AN ACT TO TRANSFER TO THE CUSTODY AND CONTROL OF THE BOARD OF REGENTS OF THE UNIVERSITY OF MINNESOTA THE LANDS GRANTED BY CONGRESS TO THE STATE BY AN ACT ENTITLED "AN ACT GRANTING LANDS TO THE STATE OF MINNESOTA IN LIEU OF CERTAIN LANDS HERETOFORE GRANTED TO SAID STATE," APPROVED MARCH THIRD (3rd), ONE THOUSAND EIGHT HUNDRED AND SEVENTY NINE (1879) TO AUTHORIZE THE SAID BOARD TO SELL SUCH LANDS AND DISPOSE OF THE PROCEEDS OF SUCH SALES.

WHEREAS, The state lands known as state salt lands, were by an act approved March tenth (10), one thousand eight hundred and seventy three (1873), chapter one hundred and thirty three (133), general laws of one thousand eight hundred and seventy three (1873), transferred to the custody and control of the board of regents of the University of Minnesota, to be by said regents sold, and the proceeds thereof held in trust by them, and disbursed in accordance with the law ordering a geological and natural history survey of the state; and

WHEREAS, It was found that certain parcels of such state lands had been otherwise disposed of by the United States to actual settlers upon such lands, for which indemnity lands have since been granted to the state by an act of Congress approved March third (3), one thousand eight hundred and seventy nine (1879); therefore

Be it enacted by the Legislature of the State of Minnesota:

Section 1. That the lands granted by Congress to this state by an act entitled "An act granting lands to the State of Minnesota in lieu of certain lands heretofore granted to said state," approved March third (3), one thousand eight hundred and

seventy-nine (1879), be and the same are hereby transferred to the custody and control of the board of regents of the university of Minnesota, which lands the said board may sell in such amounts as they may deem most expedient and beneficial, the proceeds thereof being held in trust by them, and only disbursed in accordance with the law ordering a geological and natural history survey of the state, and the said board shall make report of their doings in the premises, as provided by law.

Sec. 2. This act shall take effect and be in force from and after its passage.

Approved Feb 24, 1885.

The same Legislature appropriated a sum of money, ($12,000) for the printing and engraving necessary for volumes 2 and 3 of the final report. Of these, volume 2 is now in press, and will probably be issued during the coming year.

On the return of the collections of the survey from the New Orleans Exposition, a great deal of labor was expended in rearranging them in the museum. The rooms are more than full. Some of the cases which were returned from New Orleans are not placed in the rooms of the museum, but are stored, empty, in the Coliseum—where also are some of the specimens, because of a lack of room. At the same time the two rooms in the basement of the University which are used for general work and laboratory purposes, are very much crowded, and the progress of every department is retarded. The museum has again outgrown its accommodations. The accompanying list again will show the accessions during the year.

During July and August Mr. E. O. Ulrich was engaged in the examination of the collections of bryozoa, accumulated since the commencement of the survey. He made a good beginning in this work, and his report on the same will be found herein. There is much still to be done before a creditable and full presentation of this interesting class of fossils can be offered for final publication.

My son, Mr. H. V. Winchell, has resumed the work of collecting and listing the data of water-power utilized in the state, which was interrupted by the death of Mr. C. M. Terry. This is carried on in connection with other office and labora-

tory work, and work in the museum, and occupies but a portion of his time.

Mr. O. W. Oestlund, formerly a student of the University, and an assistant to Prof. Porter on the experimental farm, was engaged in April last, to serve as entomologist of the survey, and has been so engaged throughout the rest of the year. At a late meeting of the horticultural society of the state he was elected state entomologist to the society. Mr. Oestlund's second report is included herewith.

Mr. U. S. Grant, a student of the University has been at work casually arranging and cataloguing the collections of the survey pertaining to recent conchology. The list of recent shells found in the accompanying museum report and notes on the specimens, were prepared by him. He has had the assistance and counsel of Prof. R. E. Call, of Iowa, and of such meager literature as may be found in the University.

Mr. Warren Upham's work on the survey was terminated last April. His contributions to the geology of the state, particularly the glacial geology, have been voluminous and valuable. He has continued the same work in Dakota, in connection with the United States geological survey. A large amount of manuscript prepared by him, pertaining to the central drift-covered counties mainly, remains to be published. It will appear, according to present plans, in the second volume of the final report. Mr. Upham's careful diligence and clear-sighted apprehension of geologic facts and principles, make him not only a valuable assistant, but a reliable investigator.

Prof. J. C. Arthur, of Geneva, N. Y., was appointed botanist of the survey by authority of the board of regents, last March, but circumstances that could not be obviated have prevented him from engaging actively in this work. It is expected, however, that this department of the natural history of the state will be vigorously prosecuted during the coming year.

The manuscript reports of Dr. P. L. Hatch, on the ornithology of the state, and of Prof. C. L. Herrick, on the mammals, though not yet tendered, are understood to be in an advanced state of preparation, and will probably be completed during the coming year. In September and October, Mr. F. L. Washburn was engaged in making observations and collections for

Dr. Hatch in the northern part of the state, and has rendered some manuscript reports on his work, which has been turned over to Dr. Hatch.

The only geological field-work done in 1885, was that performed by myself in Hennepin, Ramsey, Washington, Dakota and Goodhue counties. This was intended to complete the work in those counties, and bring to a close, practically, the survey in the central part of the state. The palæontology of the primordial, Silurian and Cretaceous strata, however, is yet to be worked out fully before the geology of this part of the state can be said to be finished. Were it not for delays and interruptions incident to the publication of work already done, the field-work could be carried at once into the northern part of the state with vigor, and the survey could be brought to a close in a few years. It is hoped, however, that notwithstanding these interruptions, it will be possible during the coming summer to resume actively the work in the northern part of the state, which was interrupted in 1879.

I

NOTES ON SOME DEEP WELLS IN MINNESOTA.

BY N. H. WINCHELL.

The West hotel well, Minneapolis. This well was drilled by Mr. W. E. Swan in the summer of 1884. Its purpose was to secure a supply of good water for the West hotel. The water stands at twenty-four feet below the surface. The well is 622 feet deep. Pumping at the rate of 300 gallons per minute, lowers the water, according to Mr. Swan, about three feet in the pipe. The first water was encountered in No. 8, a white sandrock, at 168 feet, below a bed of four feet of red shale, the same that was met, with the same result, in the well at the Washburn C mill. The point of commencement of the West hotel well is from five to ten feet higher than that of the Washburn C mill. It is in the basement area, about ten feet below the surface.

		Feet.
1. Mus. Reg. No 6072. Sand drift		18
2. Mus. Reg. No 6073. Limerock (Trenton)		10
3. Mus. Reg. No. 6074. Green shales (Trenton)		10
4 Mus. Reg No. 6075. White sandrock	St. Peter Sandrock. 164 feet.	91
5. Mus. Reg. No. 6076. Yellow sandrock		30
6. Mus. Reg. No. 6077. Yellow sandrock		5
7. Red shale		4
8. Mus. Reg. No. 6078. White sandrock (first water)		10
9. Mus. Reg. No. 6079. Yellow sandrock		18
10. Mus. Reg. No. 6080. Gray sandrock		6
11. Mus. Reg. No. 6081. Red quartzyte, with calcareous cement, effervescing feebly	Reddish, quartzitic and dolomitic rock 133 feet. (Shakopee, Jordan, St. Lawrence.)	32
12. Mus. Reg. No. 6082. Fine (crypto-crystalline) limestone, hard, drab siliceous		40
13. Mus. Reg. No. 6083. Red limestone, siliceous, hard, fine, verging to the drab limestone of No. 12		10
14. Limestone, with white sand intermixed, similar to No. 12, but rather yellowish-pink than drab in color		15
15. Brown-red, hard rock, a calcareous quartzyte, some of it being a fine siliceous limestone		6
16. Fine, light-pinkish limestone, with numerous white quartz grains intermixed. The drillings are nearly half sand, but Mr. Swan thinks there is no sand in this rock (No. 16) but that the sand works in from above, which is probably true		30
17. White sand (second water)	Madison(?) 96 ft.	5
18. Fine, pinkish sand, very hard		1
19. Rounded, coarse, white sand (water increased to 20)		90
20. Calcareous shale (?)	Mendota ? 162 ft.	45
21. Green shale		104
22. Hard, sub-crystalline shale, greenish, slaty		12
23. White sandstone (third water.) Dresbach sandstone (?)		30
Total depth		622

The Lakewood Cemetery well, Minneapolis. The drilling of the deep well at the Lakewood cemetery was continued to the depth of 2,118 feet. Samples of the drillings said to have come from this depth show a reddish-brown schistose or shaly rock, like much of that above in the same drill, and apparently belonging still in the Cupriferous.

The general summary of this well given on page 54, of the 13th annual report, would harmonize better with facts derived from the deep well at elevator B. St. Paul, and perhaps with others, if it were slightly modified. With this modification there is nothing in the record to interfere.

It would be as follows:

1. Drift, 1—256 feet....256 feet.
2. White sandrock, 256—318 feet. (St. Peter.)....62 feet.
3. Dolomitic rock, 315—325 feet. (Shakopee.)....10 feet.
4. Assuming that the unrepresented interval is made up of white sandstone. 325—360 feet. (Jordan.)....35 feet.
5. Dolomitic rock, 360—403 feet. (St. Lawrence.)....55 feet.
6. White quartz sandrock, 403—504 feet. (Madison.)....101 feet.

&c. &c. &c.

The Hospital well, St. Peter. Through the co-operation of Dr. C. K. Bartlett, superintendent of the hospital for the insane, the following record has been obtained of this well: It was drilled in the fall of 1885. This well begins at the foot of the river-bluff, not far above the level of high water of the Minnesota river. There had before been excavated here a reservoir for water and a pump-house erected for throwing the water to a higher level, for the use of the hospital. This reservoir was fed by springs issuing from the sandstone, of which the bluff is mainly composed. At the depth of 116 feet the water began to flow over the top of the pipe, which was driven into the rock to protect the drill, and rose above the ground about two feet. The flow gradually increased to the bottom of the well, which is 200 feet below the point of beginning. The water will rise in a tube seven feet above the ground, or some ten feet above the original level of the reservoir, and at least twenty-five feet above the level of low water in the river. This record is valuable, as it throws light on the stratigraphy of the upper part of the Cambrian in that part of the state. The record furnished by Dr. Bartlett is as follows:

1. Gravel and loose rock....15 feet.
2. Sandrock, (Jordan)....65 feet.
3. Pink limestone, (St. Lawrence)....70 feet.
4. Gray sandrock, hard....15 feet.
5. Pink limestone rock....10 feet.
6. Red sandrock....22 feet.

Total....197 feet.

This record was very carefully kept, according to Dr. Bartlett, by the man who drilled the well. The drillings were examined by him every four feet, as the work went on. No. 2. above, is seen in the river bluff adjacent to the pump-house, and rises about twenty feet higher than the top of the well, making its total thickness about 85 feet. The rest of the bluff consists of magnesian limestone, the same that is quarried at Kasota, and continues for some distance, having a thickness of about twenty feet. It is the same as that quarried formerly at the Hospital building, and was used in its construction. It was described in the third annual report, page 143, and considered to be the Shakopee. There remains, now, some doubt whether the stone quarried at Mankato is the equivalent of this upper limestone. It seems rather to agree in thickness with the lower one.

The Mankato well, was drilled in the early part of the year 1885, but unfortunately no drillings were preserved systematically*, nor any record of the boring kept as the work proceeded. From Prof. A. F. Bechdolt the following information has been derived. The well is on the land of Mr. Carstadt, one-and-a-half blocks west of the oil-well, on Third street. It is situated within the general valley of the Minnesota, and west of the strike of the limestone bluff. It is ninety-six feet deep. The clay begins at 45 feet below the surface and is 28 feet thick. Water rose to the surface at once on penetrating through this clay, and continued to increase to its maximum, which occurred at 8 feet depth in the rock under the clay. This rock, which was entered 21 feet, is described by the owner as variable in hardness, having layers that were soft about six to twelve inches thick, alternating with hard ones that were from twelve to eighteen inches thick, the last hard layer being about three feet thick.

Prof. Bechdolt sent a single sample of the drillings from the rock below the blue clay, but from no definite horizon. They are very fine, light gray in color, homogeneous, and under the magnifier appear to be mainly quartz. When magnified about fifty diameters they show distinctly that they are mainly of angular grains of translucent quartz, not at all water-worn but pitted and reticulated. They also show a few brown scales of what appears to be some organic substance. On the application of hydrochloric acid the powder foams up somewhat, but this is due to the presence of some soluble grains, the great part of the powder being inert. The grains polarize like silica. They are not like any heretofore seen in the Cambrian, but are probably from the Cretaceous and were apparently washed from a clay or shale of that age. Museum Reg. No. 6115.

The Herman well. Mr. Charles Pullman drilled a well at Herman, for the convenience of his hotel. At 150 feet he sent a sample of gray syenitic rock containing a soft, soapy, foliated, light green mineral. At the depth of 152 feet the rock is essentially the same, but the drillings are finer and rusty. Museum Register Nos. 6116 and 6117.

The Brown's Valley well. This is an artesian well, made in 1884. It is located in the valley that runs between the Big Stone and Travers lakes, about 150 feet below the general level of the prairies in that part of the state. A stream about an inch in diameter flows from this well. The first overflow was had at the depth of 420 feet and the second at 425 feet. According to Mr. J. O. Barrett the strata in this well were as follows:

1. Blue clay, growing darker and denser to....................360 feet.
2. Dark carbonaceous shale, hard and heavy, Museum Register, No. 6112....................2 feet.
3. Gravel and sand, alternating with layers of blue clay....................58 feet.
   [At the bottom of this was the first artesian water.]
4. "Quartz rock."....................5 feet.
   [Under this was the present flow of artesian water.]
5. Greenish, micaceous, kaolinic shale, or clay. Museum Register, No 6113....................20 feet.
6. Rather coarse, angular quartz grains, apparently washed from the drillings. Museum Register No. 6114. These are generally white, opaque and wholly unwater-worn. They contain some olive-gray grains that appear to be made up of several smaller siliceous grains cemented, like some seen in the Tracy well........20 feet.

Total depth....................465 feet.

The water flows steadily, about 225 barrels each twenty-four hours, and is said to have a pressure that would cause it to rise above the surface about 200 feet. It is soft and "soaps" profusely, and possesses certain curative qualities. The strata penetrated all pertain to the Cretaceous formation. For the chemical qualities of this water, the reader may consult the analysis of Prof. J. A. Dodge in another chapter of this report.

The Milbank well. This is at Milbank, Grant county, Dakota. The following information is given on the authority of Mr. J. W. Williams. The total depth is a little over 300 feet, but granite was struck at 283 feet, (Museum Register, No. 6125,) and was drilled into about 20 feet. The alternating strata were:

1. Blue clay....................75 feet.
2. Shale....................200 feet.
3. Gravel, "clamshells" and pebbles,....................8 feet.
4. Granite....................20 feet.

Total depth....................303 feet.

The Rosenfeld Sta. well. Following is the record of this well, as given by Mr. W. E. Swan who drilled it. It is on the Canadian Pacific railway, southwestern branch, twenty miles northwest of St. Vincent. It is interesting in view of the extension of the St. Vincent salt basin so far in that direction. It was from this well that was procured the boulder-clay in which were found Cretaceous microscopic fossils as described by Dr. G. M. Dawson in the last report, p. 157.

1.	Black soil	4 feet.
2.	Blue clay	111 feet.
3.	Sand and gravel	10 feet.
4.	Hardpan, yellow	4 feet.
5.	Boulders	6 feet.
6.	Gray slate	62 feet.
7.	Yellow limerock	15 feet.
8.	Red shale	5 feet.
9.	Gray shale	10 feet.
10.	Brown shaly limestone (flow of salt water)	30 feet.
11.	Gray sand-shale	40 feet.
12.	Chalk, white	30 feet.
13.	Red shale	160 feet.
14.	Magnesian limerock (second flow of salt water)	305 feet
15.	Red shale	75 feet.
16.	Reddish sandrock	50 feet.
17.	Red shale	50 feet.
18.	Mixed red and gray shale	25 feet.
19.	Gray shale	20 feet.
20.	Red shale, quartzy	15 feet.
21.	Granite	2 feet.
	Total depth	1037 feet.

The Sleepy Eye well. This well is three miles southeast of Sleepy Eye, on the bank of the Cottonwood river. The following information is given on the authority of Mr. C. M. Phelps, who drilled the well. The granite struck at the bottom of this well is red and chloritic.

1.	Drift, (soil &c.)	28 feet.
2.	Gravel, giving water about	2 feet.
3.	Clay, without pebbles	30 feet.
4.	Gravel and sand (with water), about	2 feet.
5.	Clay like the last, (with water at 80 feet)	18 feet.
6.	Pebbly clay	100 feet.
7.	Coarse gravel, about	2 feet.
8.	"White clay," with no pebbles, containing one thin stratum of brownish red clay,	58 feet.
9.	Clay similar to the last, but of somewhat darker color	21 feet.
10.	Red granite—drilled	8 feet.
	Total depth	269 feet.

Mr. Phelps also drilled a well about four miles southwest from New Ulm, on the farm of L. Meyers. This went through "clay" about two hundred feet, and then met with a coarse sand made up of a great variety of rock-fragments, though mainly of translucent quartz. Some of the grains are rounded as completely as in some of the Cambrian sand-stones, but the most of

them are but slightly, or not at all, water-worn. Some of the quartz grains are rose-red, some are opaque-white, some are yellowish, some are from a previously granular quartzyte and contain many smaller grains, some are dark brown, some are translucent-gray, and some are of a light translucent-green. Amongst the quartz grains are also a great many that are olive-gray and opaque, like those mentioned already in No. 6 of the Brown's Valley well. The grains that are not of pure quartz, are of a dark-green to black color, and are of various kinds of hard, aphanitic rock. These dark grains constitute perhaps one-tenth part of the whole, making the mass present a pepper-and-salt aspect. The whole seems to come from the Cretaceous. Museum Register No. 6226.

The Austin deep well. The drillings from this well were presented by Mr. W. E. Swan, and were mentioned in the Museum report for 1881, page 162, with Mr. Swan's designations. The water rose to within nine feet of the surface, from a crevice which furnished water at the depth of one hundred and sixty feet. These drillings have the Mus. Reg. Nos. 4287 to 4295.

1. Black loamy soil. (4287) .... 2 feet.
2. Yellow clay, with some quartz sand; drift, (4288) .... 12 feet.
3. Drift gravel, coarse, (4289) .... 20 feet.
4. Gray, or blue, Cretaceous shale, (4290) .... 22 feet.
5. Limestone, light gray, nearly white, effervescing freely. Among these drillings are minute crinoidal beads, from one-half centimeter to one centimeter in diameter. Some of them are pentagonal, but the most are round. They have twenty-five ridges and as many grooves alternating, on each side .... 44 feet.
6. Finely arenaceous shale, light, greenish-gray, nearly white, hardly effervescing...... 16 feet.
7. These drillings indicate a limestone conglomerate, with some calcite, and a very little pyrite; the interstices between the pebbles being filled with sand, some of it being rounded white quartz. Among these drillings also are small crinoidal joints. 64 feet.
8. Light-gray, crystalline limestone, with fragments of fossils, including small crinoidal beads. Somewhat pyritiferous .... 80 feet.
9. Rounded pebble of light-gray magnesian limestone, two and one-half by three and one-half inches in diameter. This is from the depth of 160 feet, and hence from the foregoing conglomerate.

Total depth .... 260 feet.

This well seems to pass across the horizon of superposition of the Devonian on the Silurian. Some of these limestone drillings appear like the Niagara limestone, particularly No. 5, and the conglomerate suggests the horizon of the Oriskany. The "Austin rock" seems not to appear, but its place is occupied by drift and Cretaceous shale. The shale, No. 6, very much resembles that mentioned on pages 361 and 362, of vol. i. of the final report, which occurs about a mile and a half north of Grand Meadow, in this county.

[*These notes are continued in the appendix.*]

II.

LIST OF THE APHIDIDÆ OF MINNESOTA, WITH DESCRIPTIONS OF SOME NEW SPECIES.

By O. W. OESTLUND.

But few remarks will be necessary as introductory to the following list of the Aphididæ of Minnesota. The extent of territory covered is Hennepin and Ramsey counties; and the time of observation extends over the greater part of the collecting season of the present year, with some special time given to it during September and October.

From the inability to preserve specimens of this family satisfactory for study, as can be done with most of the other families of insects, I have made it a practice to take as full notes as possible of the species from living specimens as soon as found. It is from these notes that the following list has been drawn up. Probably a more prudent plan would have been to continue these notes yet for one or more seasons, in order to verify many of the observations and to be able to present a more complete list of the locality. But if allowance be made for any short-coming that will be found on account of a too limited time of observation, I think it will yet be found to contain matter that will justify its immediate presentation.

The study of this family especially presents many difficulties that can not be overcome except by patient and long extended observations over the state, with the co-operation of many observers. It is in the hope also that the following list may induce some of our naturalists and others favorably situated to aid this department by their notes and observations, as has so successfully been done in the department of botany, that as soon as possible a complete presentation can be made, not only of this family but also of others, so far as our own state is concerned.

The economical value of this study I need not here mention. Every gardener, horticulturist and farmer who has in the least observed the work of these insects, will know to what extent their injury may accrue in spite of their small size and feeble appearance. But to be able to rightly interpret the economical relation of any family or order of insects, it will first be necessary to have a full and systematic knowledge of that family, not only in regard to the species, but especially of the life histories and habits, on which to base our conclusions. Prematurely drawn conclusions and advices are too often worthless.

Not a few of our American entomologists have given considerable attention to this family, but still we are only on the threshold, as the number of species for this country, without any doubt, will be more than doubled. Among the more important works of these writers may be mentioned:

Fitch, Asa, Valuable matter will be found in many of his entomological papers.

Walsh, B. D., On the genera of Aphididæ found in the United States. (In the proceedings of the Entomological Society of Philadelphia, Dec. 1862.)

Thomas, Cyrus, Eighth report of the state entomologist on the noxious and beneficial insects of the state of Illinois, 1879. (The most complete work of all the American species that we have.)

Riley C. V., and *Monell, J.*, Notes on the Aphididæ of the United States, with descriptions of species occuring west of the Mississippi. (In the bulletin of the United States Geological and Geographical Survey of the Territories, Vol. V., No. 1, 1879.)

The systematic classification both of the species and genera found in America is still very unsatisfactory. I can offer very few or no suggestions in this line, from my knowledge of the family being too limited, and from the want of some of the more important foreign works treating of this family. The lack of literature is probably the greatest want that the frontier naturalist has to encounter. The large libraries of this country are all far off in the East, and our own are still in their infancy; it therefore often takes months if not years to procure the desired work. Some of the species on a closer study and comparison will therefore probably be found synonymous with European species, but I think it will not be in many cases, as most of them are found on plants indigenous to this country, and can be considered as native species.

In two cases have I found it expedient to erect a new genus; if valid or not future work will have to show.

In regard to the life history of the family there are two facts that I would here, as briefly as possible, call attention to. Ever since the time of Reaumer, entomologists and naturalists, in speaking of the life history of the plant-lice, have invariably had the statement to the effect that the last brood in the fall is composed of winged males and females, and that after the sexual union of these the eggs are laid by the winged females. Even entomologists of our own time have fallen into the same error, although facts to the contrary are well known; errors that too many writers fall into from quoting authors and not nature. The relation of the different forms as now known to entomologists, and which is in accordance with my own observations, I find to be as follows: The first brood, or *spring brood*, as it might well be called, is altogether composed of the apterous viviparous females, whose sole object is the multiplication of the species, or rather the growth of the colony. But as the season advances and the warm summer days have come, a different brood begins to make its appearance, composed of the winged viviparous females, and can be called the *summer brood*. These not only continue to increase the colony in the same way as the foregoing form, but in addition thereto their object is the distribution of the species, and the founding of new colonies. So far males are very rare or not to be found at all, and they have no relation to the winged viviparous females. The last brood, or *fall brood*, is composed of winged males and apterous-oviparous females, and after the sexual union of these the eggs are laid by the females for the next season. This I find to be the general rule for the family, at least for all the higher genera, and I think will give us a more correct interpretation of the different forms; although a more detailed account will show many variations and some exceptions.

A second fact is in regard to apterous males. The occurence of this form has been noticed before by some European entomologists, but the fact seems not so far to have been confirmed by our American entomologists. In the genus *Siphonophora* I have observed them in several different species, and in one (*Siphonophora frigidæ*, described in the following pages) this was the only form that could be found.

I.—Genus SIPHONOPHORA, Koch.

Head narrow and sub-quadrate.

Antennæ on distinct frontal tubercles, approximate at base; longer or at least as long as the body; third joint long, always longer than the fourth; seventh setaceous and long, sometimes longer than the third.

Eyes with a distinct tubercle; ocelli present and usually conspicuous.

Beak moderately long.

Prothorax large, smooth or transversely wrinkled; with no lateral tubercle.

Wings very long and narrow.

Legs long and slender.

Honey-tubes very long, usually extending beyond the tip of the abdomen; cylindrical, never enlarged in middle or clavate.

Style long, usually curved upwards, often compressed, falchion-shaped.

Usually found in large colonies on herbaceous, or on the leaves of woody plants.

Typical American species, *Siphonophora rosæ*, Reaum.

1. Siphonophora rudbeckiæ, Fitch.

Found abundantly throughout the season on *Solidago serotina*, Ait. and *Silphium perfoliatum*, Linn.

2. Siphonophora ambrosiæ, Thomas.

Very abundant during August and September on *Ambrosia trifida*, Linn.

3. Siphonophora frigidæ, n. sp.

Habit. Found on *Artemisia frigida*, Willd. A well characterized species on account of its shining dark-green color contrasting well with the white silky color of the plant it inhabits. In size smaller than *Siphonophora rudbeckiæ*. Winged specimens of viviparous females were seen during the summer, but no description was taken of them at the time. I can only say they were quite similar to the apterous form both in color and general appearance; the venation of the wings being as usual in this genus.

Apterous form. Of a very uniform shining dark-green color, somewhat of a metallic luster. Head narrow, subquadrate, usually slightly darker than the rest of the body. Eyes black, with a small and blunt ocular tubercle. Antennæ on prominent frontal tubercles, about as long as the body; III longest, IV a little shorter, V a little shorter than IV, VI about one-third of V, VII as long as III or sometimes longer; color black, except the base of III slightly paler. Beak moderately long, reaching

second coxæ; third joint rather long and strongly pointed; color black. Legs all black with the basal half of the femora slightly paler. Abdomen rather long, widest in the middle, cylindrical (or in oviparous females with the sides slightly emarginate,) with a row of small impressed dots of black along the margin above the insertion of the honey-tubes; dorsum is often slightly tuberculated, especially in young specimens, the tubercles giving rise to short and slender hairs. Honey-tubes black, cylindrical, reaching to the tip of the abdomen, as long again as the tarsi, not smooth, but appearing as if covered by short appressed scales when seen under the microscope. Style black, greenish at base, slightly narrowed in the middle, rounded at tip, about two-thirds as long as the honey-tubes. The anal plate of oviparous females is very long and conspicuous; black, hairy. Length of body, .08; the oviparous females are somewhat larger.

Apterous males. The occurence of this form, as noticed by a few European entomologists, is still accepted with doubt. Why so few have observed this form is probably from the fact that they have been mistaken for larva or undeveloped specimens, and therefore no special attention been given to them. That the males as a rule are winged I think there is no doubt of, and the occurence of wingless must be considered as an exception. Wingless males have been observed in both of the above mentioned species, and in one or two others belonging to this genus. In the species under consideration this form seems to be the rule and not the exception. During the summer when winged specimens were observed, only oviparous females were found, no males being seen at the time. I did not look specially for them as I felt confident they would be found further on in the season, but after a most diligent search for them during September and October, when the eggs were deposited, not a single winged specimen could be found. A great number of the wingless males, described below, were taken repeatedly during this time, and taken often in congress with the wingless oviparous females, so there can be no doubt of their being fully developed individuals.

Description. General color dark reddish-brown, in this respect differing much from the uniform greenish color of the other forms. Head of the same color with the body. Antennæ as

long as the body or usually a little longer, black, except the base of III which is slightly pale; III longest, IV and V subequal, VI one-third of V, VII as long as III, or sometimes longer. Eyes with the ocular tubercle short and blunt, no ocelli. Beak reaching second coxæ, third joint rather long and pointed. Legs black, except the base of the femora, and also the tibiæ sometimes slightly paler. Abdomen longer than broad, being rather longer and narrower than usual in males; flat above, sides margined, and with a row of black impressed dots above the insertion of the honey-tubes. Honey-tubes cylindrical, black, hardly twice the length of the tarsi, and not more than reaching to the tip of the abdomen. Style about two-thirds the length of the honey-tubes, black, narrowed at base and rounded at tip. The anal plates are black; the upper rounded at end; the lower divided into two diverging lobes or projections which are cylindrical, black, and very hairy on the under surface. Length of body, .08.

The eggs of this species are laid by the oviparous females during October in very great numbers between the leaves on top of the branches. Being tucked in between the hairy leaves they soon become firmly fastened to them by the hardening of the viscid substance that covers them when first laid, and as the leaves are persistent over winter they are well protected and in the very midst of food when the larvæ hatch the following spring. When first laid they are greenish, but soon become shining black by the hardening of the outer shell on exposure. In form oblong, cylindrical, as long again as broad, rounded at both ends, very smooth and shining; length about .03.

4. **Siphonophora chrysanthemi,** n. sp.

Habit. Found on the flower-stalks and heads of *Bidens chrysanthemoides*, Michx. What relation this species has to the European *Aphis chrysanthemi* I can not at present say. It is probable that they may be the same.

Winged form. Head black or blackish. Eyes dark reddish-brown, with a prominent ocular tubercle; ocelli present, bordered by a ring of black. Antennæ on moderately prominent tubercles, about as long as the body or a little longer; I twice as large as

II, III longest and cicatrized, IV a little shorter and nearly smooth, V a little shorter than IV, VI about one-half of V, VII nearly or quite as long as III; color black with the base of III slightly paler. Beak reaching second coxæ and as usual. Thorax with all the lobes black. Wings hyaline, veins slender, brownish; third discoidal obsolete at base; stigmal vein not much curved, straight the greater part of its length; stigma long and narrow, pointed at both ends, forming a distinct angle at the origin of the stigmal vein, yellowish-brown in color. Legs pale except the apical half of the femora, and the tip of the tibiæ with the tarsi black. Abdomen greenish-black; honey-tubes reaching to the tip of the abdomen, cylindrical, slightly thicker at base and tip, black in color. Style about one-half as long as the honey-tubes, pale, slightly curved upwards, thickest in the middle. Length of body .10; to tip of wings .16.

Apterous form. General color greenish-black, varying to a pale greenish-brown. Eyes with ocular tubercle. Antennæ shorter than in the winged form, about one-half as long as the body, or not more than reaching to the base of the honey-tubes; III, IV and V subequal, VI shortest, VII longest; blackish except at base. Honey-tubes as in winged form, but somewhat shorter, black. Style about two-thirds the length of the honey-tubes, pale. Legs pale, with the tips of the femora and tibiæ with the tarsi black. Length of body .08 to .09; very young larvæ vary considerable in color.

5. **Siphonophora granaria,** Kirby.

Found on the heads of cultivated wheat and oats, but not very often or in any great numbers. Also found more sparingly on *Phalaris canariensis*, L., or canary-grass, and on *Poa annua*, L.

6. **Siphonophora ludovicianæ,** n. sp.

Habit. Found on *Artemisia ludoviciana*, Nutt. Size large, body covered more or less by a white powder so as to be almost of the same grayish-white color as the plant, in this respect differing much from Siphonophora frigidæ as noticed above.

Winged form. Head straight or nearly straight in front; color pale yellowish-green. Eyes rather bright red; with the ocular

tubercle; ocelli present but not very conspicuous, and not bordered by a ring of black. Antennæ longer than the body; I twice as large as II, III very long, slightly cicatrized on the basal half, IV but a little shorter, V a little shorter than IV, VI one-half of V, VII usually very long; color black except the two first and the base of III; smooth, with very few scattered hairs. Beak long, slender, sharply pointed, black at tip; lobes of the thorax concolorous with the head. Wings as usual in this genus, third discoidal obsolete at base. Legs black or blackish, except the base of femora slightly paler. Abdomen green, but more or less covered by a white powder as in wingless form. Honey-tubes reaching to tip of abdomen, slightly thicker at base and truncated at tip; color black. Style long, widest in the middle, curved upwards, yellowish. Length of body .10; to tip of wings .17.

Apterous form. Size large, color pale green, but whole body rather thickly covered by a mealy substance. Eyes bright reddish-brown, with ocular tubercle. Antennæ as long as the body or longer, black; III longest, IV and V subequal, each but a little shorter than III, VI one-half of V, VII about as long as III. Beak reaching beyond second coxæ, basal half pale, rest black. Abdomen long, slightly margined, and with a row of impressed pits along the margin. Legs blackish except the base of femora. Honey-tubes and style as in the winged form. Length of body .12.

7. **Siphonophora rosæ,** Reaum.

A single colony of this species was taken September 1st, on the cultivated rose.

8. **Siphonophora erigeronensis,** Thomas.

Very abundant throughout the season on *Erigeron canadense*, L., or Canada flea-bane.

9. **Siphonophora polygoni,** Walk.

What is probably this species was seen during the summer on the common knotweed. (*Polygonum persicaria, L.*)

10. Siphonophora verbenæ, Thomas.

Found rather sparingly on the underside of the leaves of our wild verbenas.

11. Siphonophora pisi, Kalt.

This species is undoubtedly one of the most common, being found on a great number of different plants, mostly of the garden, and on introduced weeds. What I consider to be the same was also taken on *Urtica gracilis*, Ait.

12. Siphonophora achyrantes, Monell.

Found on the leaves of *Amarantus albus*, L.

13. Siphonophora corydalis, n. sp.

Habit. Found on *Corydalis aurea*, Willd. This I believe is the first species found on this order of plants.

Winged form. General color pale yellowish-green, head and thorax of a deeper yellowish color than the rest of the body. Eyes bright reddish-brown, with ocular tubercle; ocelli present and bordered by a ring of black. Antennæ on conspicuous frontal tubercles, longer than the body, black or blackish, except at base where they are pale, rather smooth, the third joint slightly cicatrized at base; I very much larger than II, III long, IV but a little shorter, V a little shorter than IV, VI about one-fourth of V, VII longest, very long and setaceous. Beak moderately long and stout, reaching second coxæ, black at tip. Prothorax rather large, transversely wrinkled; mesothorax of uniform color throughout, usually of a deep yellow, as the head; the lobes smooth and shining. Wings hyaline, stigma long and narrow; stigmal vein strongly curved, the third discoidal obsolete at base. Legs long and slender, pale except at the joints and the whole of tarsi which are black. Abdomen rather long, gradually narrowed behind, greenish. Honey-tubes very long and narrow, cylindrical, reaching beyond the tip of the abdomen and almost to the tip of the very long style, pale at base, rest all black. Style very long, about two-thirds the length of the honey-tubes, greenish, thickest in the middle, slightly

curved, gradually tapering to a point. Length of body, (style not included,) .10; to the tip of wings .18 to .20. Honey-tubes about .03.

Apterous form. Body rather long and narrow. Color of a uniform pale green. Eyes rather bright red, with tubercle. Antennæ as long or longer than the body; very similar to the winged form, but usually quite pale, except at the joints and the whole of sixth black. Legs, honey-tubes and style as in the winged form. Length of body .10.

14. Siphonophora adianti, n. sp.

Habit. Found on the underside of the fronds of *Adiantum pedatum*, L. The ferns, I believe, have generally been considered as entirely exempt from the attack of plant-lice, but this species, together with a second, described further on, will show that even this order has its peculiar species. Only apterous individuals have so far been taken. They seem to be rather widely spread, but never occuring in any great numbers; usually in small groups of five or six.

Apterous form. General color bright lemon-yellow, sometimes greenish; in size rather smaller than usual in this genus. Antennæ longer than the body, black or blackish, except the frontal tubercles and the first two joints, which are of the same color with the body; III long, IV and V subequal, VI about two-thirds of V, VII as long as III, or a little longer. Eyes reddish-brown, with tubercle. Beak very short and stout, not reaching to the second coxæ, rather bluntly pointed, hairy and black at tip. Abdomen rather wide and rounded behind. Legs pale, except the tips of the tibiæ and the tarsi, which are black. Honey-tubes long and slender, reaching beyond the tip of the abdomen and about twice the length of the tarsi, pale, except tip sometimes dusky. Style about one-half the length of the honey-tubes, rather thick and conical. Length of body .06 to 07.

Eggs of this species, taken during October, were deposited on the under side of the fronds. In form cylindrical, rounded at both ends, a little longer than broad, very smooth and shining. When seen they were pale in color, but undoubtedly became black on exposure as usual in this genus.

II.—Genus MACROSIPHUM, g. nov.

Head more transverse and larger than in *Siphonophora*.
Antennæ on moderately large and not approximate frontal tubercles; longer than the body, (at least in the winged form); the third and seventh joint longest.
Eyes large and round, with a distinct tubercle; ocelli present and very conspicuous.
Beak moderately long.
Prothorax large, with a lateral tubercle.
Wings long and narrow; sometimes clouded at tip.
Legs long and slender.
Honey-tubes very long, extending far beyond the tip of the abdomen; usually much dilated in the middle and slightly curved.
Style long and conspicuous.

The species on which this genus has been founded is very similar to Kaltenbach's *Siphonophora rubi*, although apparently specifically distinct, and would therefore probably with it be included in that genus. But the dilated honey tubes, robust style, prothoracic tubercle and clouded wings (at least in the female) I think will justify a separation. What importance can be put on some of these characters I can not here discuss, but I have reason to believe that these together with other facts show a higher differentiation than even Siphonophora, and in a strictly systematic arrangement would come before that genus.

1. Macrosiphum rubicola, n. sp.

Habit. Found clustered around the tender twigs and underside of the leaves of *Rubus strigosus*, Mx. A very large and most elegant species.

Winged form. General color whitish or yellowish-white. Head transverse, straight in front, more or less dusky above. Antennæ as long as the body or often considerably longer, on moderately conspicuous frontal tubercles, not approximate at base; the frontal tubercles as well as the base of third joint whitish (sometimes the fourth and fifth joints are also pale at base), rest all black; I and II as usual in this section, III the longest, IV a little shorter, V a little shorter than IV, VI the shortest and about one-third or one-fourth of V, VII long and setaceous, often as long as III; III more or less tuberculate. Eyes large, reddish-brown, with a distinct tubercle; ocelli present and very conspicuous; bordered by a ring of black. Beak moderately long, reaching second coxæ, or slightly beyond, stout and rather hairy, whitish at base and dusky at tip. Prothorax very large, sides slightly emarginate, and with a distinct lateral tubercle,

rather robust. Lobes of mesothorax shining black above, the ventral of a dull black. Wings long and narrow; stigma very long and broad, pointed in front and behind, forming a distinct but very obtuse angle at the origin of the stigmal vein; dusky or almost black; tip of wings smoky, this clouded patch is between the third discoidal and the stigmal vein, extending partly into the stigmal cell; stigmal vein strongly curved at base, rest nearly straight. Legs long and slender, femora whitish with their tips black; tibiæ dusky with their tips, together with the tarsi, black. Abdomen longer than broad, sides parallel and but a little wider at the middle than the thorax; flat, with impressed pits along the slightly margined sides; color whitish with some green markings above, the ventral greenish-white. Honey-tubes very long, extending more than half their own length beyond the tip of the abdomen; slightly attenuated near the base, then gradually enlarging, becoming thickest above the middle, where they are at least twice as thick as at base, again more rapidly contracting near the tip, ending as usually in a flat rim. Being more strongly enlarged on one side they become slightly bent; color dusky especially at the base and tip, but transparent, the liquid globules being visible. Style cylindrical, or but slightly narrowed near the base, bent upwards, with but few hairs and of the same color with the body. In length about one-fourth the honey-tubes or about twice the length of the tarsi.

Length of body (style or honey-tubes not included) .10—.12; to the tip of the wings .18—.20.

Winged male. Found as late as November the 1st, together with the oviparous wingless females. Head transverse, considerably broader than long, black or blackish. Antennæ longer than the body, on rather prominent frontal tubercles; relative length of the joints the same as in females; all black. Eyes large and prominent, with tubercle; ocelli present, bordered by a ring of deeper black than that of the head. Beak reaching second coxæ, blackish. Prothorax well developed, as long as the head, lateral tubercle more or less obvious. Mesothorax shining black. Wings as in female, but the stigma is not so black, and the smoky patch at the tip of wings wanting. Legs all black, except the base of femora and tibiæ slightly paler. Abdomen blackish-green, short, with more or less black markings on the

dorsum. Honey-tubes very long, reaching beyond the tip of the style, sub-cylindrical, enlarged only at the very tip where they are trumpet-shape; black. Style as in females. Anal plates conspicuous, black, and very hairy, especially the lobes of the lower plate. Length of body .08; antennæ .12; to the tip of wings .20.

Apterous form. General color during summer very pale, whitish, becoming pale lemon-yellow late in the season. Head straight in front. Antennæ seem to vary much in length from much longer than the body to shorter, (especially all those examined late in the season had them shorter than the body,) the relative length of the joints as in foregoing forms; color the same with the body, with the tips of the upper joint and the whole of the sixth blackish. Eyes moderately large, dark reddish-brown with tubercle; no ocelli. Beak rather long and stout, reaching slightly beyond the second pair of coxæ, first and second joints subequal. Prothorax with a more or less obvious lateral tubercle. Abdomen long and narrow, widest at the insertion of the honey-tubes. Legs very pale, except the tips of tibiæ and the whole of tarsi, which are black. Honey-tubes as in the winged female, very pale or whitish throughout, or with the tips black, this being the case with all taken late in the season. Style shorter than in winged female, not much longer than the tarsi, cylindrical, with but few hairs, of the same color with the body.

III.—Genus MEGOURA, Buckton.

Head broad; straight in front.
Antennæ much longer than the body; frontal tubercles large; remote at base; third joint longest; second twice the size of the first; fourth longer than the fifth; seventh setaceous.
Eyes with tubercle; ocelli present.
Beak rather short.
Wings and legs as in Siphonophora.
Honey-tubes long, dilated in the middle, expanded at the end, or trumpet-mouthed.
Style markedly long and thick.
Habit sporadic.

1. Megoura solani, Thomas.

Found on the common tomato. This peculiar species is by no means rare in the gardens around Minneapolis, although never found in great numbers on any one plant.

IV.—Genus MYZUS, Pass.

Head transverse.
Antennæ on moderately large tubercles; these gibbous on the inner side, as is also the first antennal joint; about as long as the body.
Eyes with a distinct tubercle; ocelli present.
Prothorax usually with the pronotum narrowed in the middle.
Legs moderately long.
Wings very much as in Aphis.
Honey-tubes reaching to the tip of the abdomen, cylindrical, or slightly enlarged toward the apex.
Style rather short.
Habit. Mostly found on the foliage of plants belonging to the rose family; some species causing the leaves to cup and become deformed.
Typical American species, *Myzus ribis*. L.

1. Myzus cerasi, Fab.

This species seems to be found wherever the cherry is cultivated. So far as I am aware it has not shown itself specially troublesome in this state.

2. Myzus ribis, Linn.

Found plentiful on the cultivated currants, causing the leaves to curl up, forming corresponding crispy swellings above. When they become very numerous on a bush they cause the leaves to turn yellow and to drop off, as I noticed in several instances.

3. Myzus potentillæ, n. sp.

Habit. Found on the underside of the leaves of *Potentilla anserina*, Linn.

Winged form (males). General color yellowish-green. Head rather broad, slightly convex in front, black or blackish. Antennæ longer than the body, black; the third slightly pale at the very base; tubercles moderately prominent, gibbous; I gibbous, II as usual, III very long and tuberculate on the underside, IV and V subequal, each shorter than III, VI one-half or one-third of V, VII as long as III or usually longer. Eyes large, reddish-brown, with distinct tubercle; ocelli present, bordered with a ring of black. Beak reaching second coxæ, pale at base, black at tip, last joint rather sharply pointed. Prothorax with the pronotum narrowed in the middle, blackish; membrane greenish. Mesothorax yellowish with the lobes and the scutellum shining black. Legs black, with the base of the femora and tibiæ paler.

The wings as usual. One specimen examined had one of the wings very abnormal, the first discoidal being completely obsolete, the second so except a very short distance near its origin, the third discoidal with but one branch. Abdomen greenish with more or less black on the dorsum in form of transverse bands. Honey-tubes cylindrical, reaching to the end of the abdomen, or in some beyond, pale, in length about three times the tarsi. Style very short, pale except sometimes at the tip, hairy. Upper anal plate of the same color as the body, lower blackish, at least the lobes. Length of body .06, wings included .10.

Wingless form. Oblong and rather convex. General color pale green; covered with small tubercles that give rise to strongly capitate or knobed hairs. Some of these knobed hairs are also found on the front of the head, on the frontal tubercles and on the first and second joints of the antennæ. Antennæ commonly a little shorter than the body, pale, but sometimes the apical joints are dusky; III, IV and V subequal, VI one-half of V, VII about as long as III. Eyes reddish-brown, with the tubercle. Legs pale, except tips of tibiæ and the tarsi slightly dusky. Honey-tubes pale, cylindrical, about three times the length of the tarsi. Style pale, short, about as long as the tarsi. Length of body .06 to .07.

The eggs. These are laid on the underside of the leaves, and as these do not fall off but remain attached to the plant over winter they afford a very good protection, and the young larva on hatching in the spring has but a short walk to make to find the new growth. They are pale green when first laid but soon become shining black; cylindrical, very smooth, rounded at both ends.

4. Myzus malvæ, n. sp.

Habit. Found on the underside of the leaves of *Malva rotundifolia* Linn. This can not be *Siphonophora malvæ* of European authors, and I know of no Myzus ever found on this common plant.

Winged form. Head and thorax shining black; abdomen green. Head transverse, pointed in the front as in aphis. Antennæ about as long as the body, black, except base of third joint; on

distinct frontal tubercles, and these very much prolonged or gibbous on the inner side; I gibbous, II as usual, III longest, IV a little shorter, V a little shorter than IV, VI about one-half of V, VII setaceous, about as long as IV. Beak reaching second coxæ. Eyes dark reddish-brown, with prominent tubercle; ocelli present. Prothorax with the pronotum narrowed in the middle, black; membrane pale. Lobes of mesothorax shining black. Legs with the apical half of femora black, tips of tibiæ and the tarsi black, rest paler. Wings as usual in this genus. Abdomen not much longer than wide, sides rounded; color pale green with a large subquadrate patch of darker green on the dorsal side, and with a row of black spots along the margins above the insertion of the honey-tubes as in *Aphis mali*. Honey-tubes reaching to the tip of the abdomen or slightly beyond, cylindrical, or generally a little thicker towards the apex, more or less dusky, the liquid drops visible through it. Style about half as long as the honey-tubes or about as long as the tarsi, cylindrical or very slightly narrowed near the base and bent upwards, hairy. Length of body .06; to tip of wings .14.

Apterous form. General color pale-green. Antennæ about half as long as the body, not reaching to the base of the honey-tubes; pale at base, rest blackish. Eyes reddish-brown, with tubercle. Abdomen pale green, (with a middle and sometimes marginal longitudinal band of darker green); not tuberculate nor with capitate hairs. Honey-tubes and style as in winged form but usually quite pale. The frontal tubercles and first joint of the antennæ very gibbous.

V.—Genus DREPANOSIPHUM, Koch.

Antennæ on frontal tubercles, usually longer than the body; third and last joints longest; fourth and fifth equal.
Eyes large and with a distinct tubercle; ocelli present.
Beak short.
Prothorax with no lateral tubercle.
Wings long and narrow; marginal cell elongated towards the apex of the wing.
Legs moderately long.
Honey-tubes moderately long, enlarged beneath towards the base.
Style inconspicuous or none.
Habit sporadic.

1. **Drepanosiphum acerifolii,** Thomas.

This peculiar species is by no means rare on the soft maple (*Acer dasycarpum*, Ehrh.) in and around the city of Minneapolis.

VI.—RHOPALOSIPHUM, Koch.

This genus is mostly characterized by American entomologists simply as similar to *Aphis* or *Siphonophora*, but with the honey-tubes distinctly clavate. As far as our American species are concerned, this is probably one of the most difficult genera to define in the family. If we on one hand take *Rhopalosiphum rhois* as a type, we have a species that is similar to *Aphis*, and could well be put in that genus with the exception of the clavate honey-tubes; if on the other hand we take *Rhopalosiphum nabali* (described below) as a type, we have a species that could well be put in *Siphonophora* but for the distinctly clavate character of the honey-tubes. If *Rhopalosiphum ribis, Koch*, prove to be a distinct species as found on our native currant (Ribes nigrum, L.), from *Myzus ribis*, L., as found on the cultivated currant, we have still another species that shows a close relation to *Myzus*. Wherefore we have to rely almost exclusively on but one single character. Now if this clavate character of the honey-tubes prove to be constant, so that we can rely on it in all cases, the genus could well be accepted to include all the species that I have included in the following; but if this character should be found to vary, as I have reason to believe, most of the following species will have to be located in other genera.

1. **Rhopalosiphum rhois,** Monell.

Found rather common on the underside of the leaves of *Rhus glabra*, Linn.

2. **Rhopalosiphum ribis,** Koch.

Found on the underside of the leaves of wild currant (*Ribes nigrum, Linn.*), and as far as I observed not causing the leaves to cup as in the case with *Myzus ribis*, Linn., found on the cultivated currant. It is probably but a variety of this last named

species, though the honey-tubes are distinctly clavate and would locate it here.

3. Rhopalosiphum sonchi n. sp.

Found on *Sonchus asper*, Vill.

Winged form. Head transverse, straight in front, or but slightly convex, more or less black above. Antennæ about as long as the body, black except the base of the third joint slightly paler, on rather small frontal tubercles, and these somewhat gibbous or enlarged on the inner side; I much larger than II, III long, IV a little shorter, V a little shorter than IV, VI about one-third of V, VII as long as III or often very short; III and IV are strongly tuberculated and cicatrized, especially on the under side. Eyes large, reddish-brown, with a distinct tubercle; ocelli present and conspicuous as a glassy point bordered by black. Beak as usual, reaching second coxæ, pale except at tip. Prothorax with the pronotum narrowed in the middle, black; membrane greenish. Lobes of mesothorax all shining black. Wings hyaline; costal veins yellowish, the rest brownish; third discoidal obsolete at base. Legs pale except at the joints, where they are dusky or black; tarsi black. Abdomen pale green, with a marginal row of black spots, and in the middle a large subquadrate patch of black, as wide as the distance between the honey-tubes; ventral uniformly greenish. Honey-tubes reaching to the tip of the style, narrow at base, then expanding, becoming widest a little above the middle, where they are at least twice as wide as at base, again contracting near the tip ending in a flat rim; color pale, dusky only at the tip. Style about half as long as the honey-tubes, cylindrical, point rounded, hairy and bent upwards, yellowish. Length of body .08; to tip of wings .16; honey-tubes .02.

Wingless form. General color pale-greenish. Antennæ as in winged form, but pale, or joints dusky only at tips. Legs pale, tarsi black. Honey-tubes the same but somewhat thicker, and not so distinctly clavate.

4. Rhopalosiphum nabali, n. sp.

Habit. Found on the flower-heads of *Nabalus albus*, Hook.

Winged form. Head broader than long and nearly straight in

front; color brownish-black. Antennæ on rather short frontal tubercles, about reaching to the honey-tubes; III longest, IV a little shorter, V a little shorter than IV, VI short, about one-fourth of V, VII seems usually to be short, not longer than VI, in only one specimen out of a dozen did I find one that had it as long as III, black in color, and III and IV rather strongly tubercular as in the foregoing species. Beak reaching second coxæ, or but slightly beyond it, pale except at tip. Prothorax with the pronotum narrowed in the middle; color shining brown or blackish, as are the lobes of the mesothorax. Eyes reddish-brown, with tubercle; ocelli present, bordered by black. Wings with the costal veins yellowish, rest brownish; stigma long and narrow; third discoidal obsolete at base. Legs blackish except basal half of femora. Abdomen greenish with a longitudinal middle and marginal band of blackish. Honey-tubes reaching beyond the tip of the style, strongly club-shaped, narrow near the base, then enlarging, becoming at least twice as wide as at base, again contracting more moderately near the tip, ending in a flat rim, brownish or black, base usually paler. Style rather long, about one-half the honey-tubes, slightly enlarged in the middle, bent upwards, hairy and yellowish in color. Length of body .10; to the tip of wings .20.

Wingless form. General color a dusky-green with head and thorax usually yellowish-green. Antennæ about two-thirds the length of the body. Honey-tubes and style as in winged form. Legs pale except at the joints, where they are slightly dusky. Wing-pads of the pupæ pale yellow.

This species comes nearer to *Siphonophora* than *Aphis* in size, color and general appearance, but the honey-tubes are distinctly club-shaped, and the frontal tubercles are but moderately large and hardly approximate.

VII.—SIPHOCORYNE, Pass.

Head transverse, rounded in front.
Eyes with a distinct tubercle; ocelli present.
Antennæ on no perceptible frontal tubercles; shorter than the body and usually strongly cicatrized and tuberculated.
Beak moderately long.
Wings and legs as in Aphis.
Honey-tubes distinctly clavate; moderately long.
Style short.
Typical American species: *Siphocoryne xanthii.*

1. Siphocoryne xanthii, n. sp.

Habit. Found on the leaves of *Xanthium canadense,* Mill. (X. *strumarium* of Gray's Manual).

Winged form. General color yellowish-green, some more decidedly green than others. Head transverse, rounded in front, more or less dusky above. Antennæ on no perceptable frontal tubercles, about one-half the length of the body, or a little longer, blackish except near the base; III longest and as long as IV and V together, IV and V subequal, VI about one-half of V, the setaceous VII about as long as III; III and IV strongly tubercular. Eyes reddish-brown, with tubercle; ocelli present, bordered by a ring of black. Beak short, not reaching second coxæ; last joint short and pointed, dusky. All the lobes of thorax blackish. Wings hyaline, and venation much as in *Siphonophora.* Legs pale, except at the tip of the joints blackish. Abdomen oblong, yellowish-green with transverse markings of darker green; ventral uniformly greenish. Honey-tubes reaching to the tip of the abdomen or slightly beyond, pale, basal half slender, then enlarging in the middle to nearly twice the diameter at the base, again contracting near the tip, ending in a flat rim. Style short, about as long as the tarsi, pointed, curved upwards, hairy. Length of body .08; to tip of wings .14.

Apterous form. Color pale greenish, with dorsal markings of darker green; ventral uniformly green. Body with short capitate hairs. Antennæ one-half as long as the body, pale. A red variety is also seen among very young specimens.

2. Siphocoryne archangelicæ, n. sp.

Habit. Found on the umbels of *Archangelica atropurpurea,* Hoffm. It is possible that this is *Aphis archangelicæ* of Linnæus, but I have no access to his description at present.

Winged form. Head transverse, pointed in front, brownish-black. Antennæ on no frontal tubercles, not more than one-half the length of the body, black or blackish; III longest and about as long as the three following joints taken together, IV, V and VI being subequal, VI being slightly the shortest, the setaceous VII also very short; III, IV and V are strongly tubercular, III especially so. Eyes dark reddish-brown, with

tubercle; ocelli present, but not very conspicuous. Beak moderately long and slender, reaching to the second coxæ. Pronotum of the prothorax narrowed in the middle, concolorous with the head; membrane greenish. Lobes of thorax shining black. Legs pale, dusky at joints. Abdomen rather long, sides straight, yellowish-green with a large subquadrate patch of black in the middle; ventral uniformly colored. Honey-tubes reaching to the tip of the style, enlarging in the middle to about twice the diameter at the base, again becoming narrow near the apex, where they are about as wide as at base, ending in a flat rim. Style rather short and acute, pale. Length of body .09; to tip of wings .17.

Apterous form. General color yellowish-green. Antennæ very short, not one-half the length of the body; joints proportional very much as in winged form. Honey-tubes reaching to tip of abdomen, dusky, in form as above. Style short and conical. Beak reaching second coxæ. Legs rather short and stout. Length of body .08 to .09.

VIII.—Genus APHIS, Linn.

Head transverse, rounded in front; seldom straight.

Eyes moderately large or large, with a more or less distinct tubercle; ocelli present, but usually not very distinct.

Antennæ remote at base, not on frontal tubercles, or on very inconspicuous ones; usually smooth, and generally shorter than the body.

Beak moderately long.

Pronotum of prothorax usually narrowed in the middle, and often with a lateral tubercle.

Wings deflexed, and of the usual form.

Legs generally short and stout.

Honey-tubes cylindric or sub-cylindric, moderately long, very rarely none.

Style usually short, very rarely none.

Usually found in large colonies on annual plants.

Typical American species: *Aphis mali*, Fab.

Although this genus has many times been restricted, it is still one of the most unwieldy in the family. A well defined subdivision would therefore be very desirable, but it will require a very careful and special study of the whole genus as found in America. At present I can offer no suggestions in this line, and will only attempt to define as fully as possible the apparently new species, without any satisfactory order of arrangement.

1. Aphis frondosæ, n. sp.

Habit. Found on *Bidens frondosa,* Linn. Usually in very great numbers.

Winged form. Head transverse, rounded in front, black. Antennæ about as long as the body, black, on no frontal tubercles, as seen from the side, but on the inner side with rather strongly projecting lobes, as seen from above; III longest, IV and V subequal, VI about two-thirds of V, setaceous VII about as long as III: smooth, but III, IV and V are cicatrized, having a row of regularly placed spots on the under side, V with but a few, and rather far apart. Eyes reddish-brown, with tubercle; ocelli present. Thorax of uniform black. Abdomen greenish and more or less mottled with black markings above, forming a subquadrate patch not well defined. Honey-tubes reaching tip of abdomen, cylindrical, black. Style greenish-yellow, cylindrical, slightly curved upwards, about one-half the length of the honey-tubes, or about as long as the tarsi. Legs black with the front femora pale, and the tibiæ more or less pale in the middle. Wings hyaline, with narrow blackish veins; origin of the second branch nearer to the tip of the wing than to the origin of the first branch. Length of body .07; to tip of wings .14 to .15.

Apterous form, The pupa has the antennæ about as long as the body, blackish. Thorax greenish, wing-pads blackish. Abdomen pale green, yellowish around the honey-tubes, with a large subquadrate patch of dull green in the middle blending with the pale green of the body. Honey-tubes black, thickened slightly at base. Style short, conical. Length of body .07.

2. Aphis ageratoidis, n. sp.

Habit. Found on the flower-heads of *Eupatorium ageratoides,* Linn.

Winged form. Head transverse, slightly pointed in front, black. Antennæ on very inconspicuous frontal tubercles seen as lobes on the inner side, about two-thirds the length of the body, black; III long, IV a little shorter, V a little shorter than IV, VI about two-thirds of V, VII the longest; III and IV are regularly cicatrized on the under side, but not as promi-

nently so as in the foregoing species. Eyes reddish-brown, with tubercle; ocelli present. Beak reaching second coxæ, pale. Prothorax with the pronotum much narrowed in the middle and with a distinct lateral tubercle, black; membrane greenish; rest of thorax of a rather dull black. Wings as usual. Legs black except at the joints. Abdomen pale yellow, or sometimes light brownish, with a patch of dark green in the middle which is much longer than broad; ventral pale yellow. Honey-tubes reaching the tip of the style, blackish. Style rather slender, cylindrical, hairy, pale yellow and about as long as the tarsi. Length of body .06; to tip of wings .12.

Apterous form. General color pale yellow. Antennæ pale at base, rest blackish. Eyes with ocular tubercle; the pupa with brown uniform spots as rudiment of the future ocelli. Beak black at tip. Wing-pads of the pupa black, except at base. Legs pale except the apex of the tibiæ. Abdomen with a patch of dark green in the middle, this patch much longer than broad. Honey-tubes black, slightly thickest at base. Length of body .06. This species is very close to *Aphis frondosæ*, but in size it is somewhat smaller, in color paler. and the patch of the abdomen is always longer than broad, while that of *frondosæ* is subquadrate and not so well defined, but blending with the general color of the body.

3. Aphis eupatorii, n. sp.

Habit. On the flower-heads of *Eupatorium perfoliatum*, Linn.

Winged form. Head transverse, nearly straight in front or but a little rounded. Antennæ rather short, not more than two-thirds the length of the body, black except the base of the third joint; III longest, IV and V subequal, each considerable shorter than III, VI shortest about two-thirds of V, VII as long as V, III and IV cicatrized but not regular nor as well marked as in the two foregoing species. Eyes large, reddish-brown, with a very prominent ocular tubercle; ocelli present. Beak rather long and slender, reaching nearly to the abdomen. Prothorax with the pronotum narrowed in the middle; sides with a very distinct mammiform tubercle, black; membrane paler; rest of thorax black. Legs pale or of the same color with

the body, with the joints blackish. Abdomen yellowish or greenish-yellow, with a marginal row of black spots, and the last segments more or less blackish. Honey-tubes rather short, hardly reaching tip of the abdomen, and not much longer than the rather long tarsi, cylindrical, ending in flat rim, pale. Style conspicuous and nearly as long as the honey-tubes, cylindrical, curved upwards, hairy, yellowish in color. Length of body .07 to .08; to tip of wings .14.

No description was taken of the wingless forms at the time, so I can say nothing in regard to them, but the species can easily be recognized from the two foregoing from a somewhat larger and more robust form, the form of the antennæ, and the rather short honey-tubes but long style.

4. **Aphis marutæ,** n. sp.

Habit. Found on the flower-stalks of *Maruta cotula*, D. C.

Winged form. Head transverse, rounded in front. Antennæ on inconspicuous frontal tubercles, but these slightly prolonged on the inner margin, nearly as long as the body, all black except base of third joint; III long, IV but a little shorter, V a little shorter than IV, VI about one-half of V, VII as long as III; III and IV quite tubercular, especially on the under side, but very slightly and indistinctly cicatrized. Eyes dark reddish-brown, with tubercle; ocelli present. Beak reaching second coxæ, blackish. Thorax uniformly black; pronotum of prothorax narrowed in the middle with no lateral tubercle. Legs with the base of femora and tibiæ pale, rest black. Abdomen pale green, with more or less black markings above; ventral uniformly pale green. Honey-tubes rather short and stout, cylindrical or slightly enlarged in the middle, black. Style short, conical, concolorous with abdomen slightly dusky. Length of body .06; to tip of wings .12.

Abdomen greenish, with a marginal row of black spots above the honey-tubes, in the middle a large subquadrate patch of black.

Wingless form. General color greenish. Antennæ about one-half the length of the body, basal half pale, rest blackish. Pupa with the tips of wing-pads black. Honey-tubes short and usually a little thicker at the base, blackish.

This species is very similar to *Aphis eupatorii*, but is easily recognized by the large patch of black on the abdomen, and that the prothorax have not got the lateral tubercle found in the three foregoing species.

5. **Aphis mali**, Fab.

This species has been found very abundant throughout the season on the common apple, crab-apple, and also on the mountain ash. As far as I am aware it has not been noticed on the last named before. Wherever noticed the eggs were laid very numerous during October and November, on the trunks, twigs and annual shoots of the trees. It would be well to have the annual shoots and supernumerous twigs burnt in the fall or early spring before the eggs hatch, if they are found to be thickly stocked with eggs, as it would go so far towards diminishing their numbers. The eggs are pale green when first laid but soon become hard and black, very smooth, cylindrical, about as long again as broad.

6. **Aphis pruni**, Koch.

This species was noticed once on a young plum tree, but not very numerous.

7. **Aphis maidis**, Fitch.

This species, found on the Indian corn, is probably found now wherever corn is cultivated.

8. **Aphis apocyni**, Koch.

A species found on *Apocynum cinnabinum*, I take on Dr. Thomas' authority as identical with the European species as I neglected to take any notes or make comparison when found.

9. **Aphis ripariæ**, n. sp.

Habit. Found on the underside of the leaves of *Vitis riparia*, Michx.

Winged form. Head slightly pointed in front, of a dull black. Frontal tubercles very inconspicuous, only a slight projection on

the inner side. Antennæ about as long as the body, black except base of third joint; III longest, IV and V subequal, VI about two-thirds of V, VII nearly as long as III, setaceous; III and IV moderately pustulate on the under side not apparently cicatrized. Eyes reddish-brown, with ocular tubercle; ocelli present. Beak reaching second coxæ. Prothorax with the pronotum narrowed in the middle, black; membrane greenish; sides with a prominent tubercle. Thorax dull black. Second branch rather short, nearer to the tip than origin of the first. Legs pale except at the joints, black. Honey-tubes reaching tip of abdomen, about twice as long as the tarsi, cylindrical, or but slightly thickest at base, black. Style about as long as the tarsi, cylindrical, rounded at tip, hairy, pale in color. Length of body .08; to the tip of wings .15.

Wingless form. General color pale yellowish-green. Antennæ about one-half the length of the body or a little longer, and usually quite pale. Legs pale except at the tips. Honey-tubes as in winged form, slightly dusky at tip. The joints of the antennæ are nearly equal in length, except the last usually being the longest; the division of joint III and IV is very indistinct. General form of the body rather long and narrow, in this respect, showing same relation to Siphonophora.

10. Aphis polanisiæ, n. sp.

Habit. Found on the seed-pods and occasionally also on other parts of the plant of *Polanisia graveolens*, Raf. The first species found on a plant of this order I believe.

Winged form. Head strongly transverse, rounded in front, black. Antennæ one-half or not more than two-thirds the length of the body, black, on very inconspicuous frontal tubercles; III longest, IV about two-thirds of III, V a little shorter than IV, VI one-half of V, VII about as long as III; III and IV strongly tubercular and cicatrized. Eyes blackish with a large ocular tubercle; ocelli present. Prothorax with a moderately distinct lateral tubercle; thorax as a whole black. Wings as usual in the genus, but coming near to the type of *Siphonophora;* stigmal vein but slightly curved. Legs rather long and slender; femora pale at base; tibiæ rather pale except at apex together

with the tarsi which are all black. Abdomen greenish-black. Honey-tubes rather short and thick, not reaching tip of abdomen, and hardly twice the length of the tarsi. Style about as long as the tarsi, and as usual. Length of body .06; to tip of wings .12 to .14.

This species, like the one found on the common tomato, have often got their feet clogged with the viscous substance of the plant, so as to appear club-footed.

Wingless form. These are usually found on the pods, congregating in small colonies, and rather uniformly of the same green color as the pods.

11. Aphis annuæ, n. sp.

Habit. On the leaves and flowering-stem of *Poa annua*, L., found together with *Siphonophora granaria*, but this species generaly was found only on the leaves and lower part of the plant, while the aphis on the upper.

Winged form. Head and thorax of a shining black; abdomen of a dull green. Head transverse as usual, and rather strongly pointed in front. Antennæ a little shorter than the body, on no frontal tubercles but only a small projection on the inner side taking the place of it, all black; III long, IV a little shorter, V shorter than IV, VI about one-half of V, VII as long as III or sometimes longer, setaceous; the middle joint but moderately tubercular and indistinctly cicatrized. Beak as usual, black at tip. Eyes with ocular tubercle; ocelli present. Prothorax with no lateral tubercle, and as well as the rest of thorax shining black. Wings rather long and narrow; stigmal vein but moderately curved; second branch of the discoidal very short and near to the tip. [One specimen examined had the second branch missing on one of the wings, the other being normal.] Legs more or less pale. Abdomen of a dull green, sometimes with a marginal row of black spots, but usually quite uniformly colored throughout. Honey-tubes short, hardly twice the tarsi and not reaching tip of abdomen, cylindrical or slightly narrower on the basal half and near the tip, tip ending in a flat rim, color black. Style short, cylindrical, about as long as the tarsi, black. Length of body .07; to tip of wings .14.

Wingless form. The larvæ are rather short with the abdomen wide and strongly rounded behind, of a dark dusky green. Antennæ reaching base of honey-tubes, dusky.. Honey-tubes as in winged form but usually pale at base. Style very short, conical. Length of body .06 to .07.

This species is readily recognized from the closely related species by the very short second branch of the wings.

12. Aphis asclepiadis, Fitch.

Found in colonies on the upper leaves of *Asclepias cornuti*, Linn. Apparently Aphis and not Siphonophora as Doctor Thomas considers it. This I found to be very common in this part of the state.

13. Aphis brassicæ, Linn.

It can usually be found on the cabbage wherever it is cultivated. They occur in small colonies distributed over the outer leaves, and for the last season have been found very numerous in certain localities of this state.

14. Aphis ceracifoliæ, Fitch.

Found on the upper leaves of *Prunus virginiana*, Linn., causing them to twist and curl.

15. Aphis loniceræ, Monell.

This very peculiar species was once taken on *Lonicera glauca*, Hill.

16. Aphis phragmitidicola, n. sp.

Found on the leaves of *Phragmitis communis*, Linn., in small colonies along the midrib. It is possible that this may be the Linnean species *arundinis*, but at present I have no means to ascertain this and will therefore describe the species as found here.

Winged form. Rather long and narrow, somewhat flattened. Head and thorax black and with a slight pulverulent. Antennæ about as long as the body, dusky except at base, on no frontal

tubercles or only a very slight lobe seen on the inner side; I sometimes slightly gibbous, III longest, IV a little shorter, V a little shorter than IV, VI about one-half of V, VII usually as long as III; smooth and apparently not cicatrized. Eyes reddish-brown, with ocular tubercle; ocelli present. Beak rather short and blunt, not reaching second coxæ, pale except at tip. Thorax with the lobes black; prothorax rather large, green in color, with a very small and inconspicuous lateral tubercle. Wings with the stigma long and narrow; stigmal vein but moderately curved; third discoidal obsolete at base. Legs moderately long and slender, pale except at joints, where they are slightly dusky. Abdomen long and narrow, sides straight, tapering behind, flat; color uniformly pale green. Honey-tubes short, hardly as long as the tarsi, and but a little longer than broad, cylindrical, rounded at tip, slightly dusky. Style larger and more conspicuous than the honey-tubes, about as long as the tarsi, cylindrical, sometimes slightly curved upwards, hairy. Length of body, .06; to tip of wings .12.

Wingless form. Long and narrow, flattened. Color pale green, with marginal and a middle band of dark-green; more or less covered with a white powder. Beak short and thick, not reaching second coxæ. Legs pale except the tips of the tibiæ and the tarsi. Honey-tubes and style as in the winged form. Antennæ a little shorter than the body or else as in the foregoing form. This species has the honey-tubes situated rather far up on the abdomen.

17. **Aphis middletonii,** Thomas.

This interesting species was taken abundantly during the summer on the roots of *Erigeron canadensis.* This species is usually protected by some colony of ants, who will take them up and carry them off to some safe place as soon as disturbed. If this is but a dimorphic form, as Doctor Thomas suggests, it will probably develop another interesting page in the life history of this family. But as far as my own observations go I can add nothing to it. The winged form so far has never been found. This species, although living under ground, is not exempt from parasites, as some species of Aphidius penetrate even to their deep abode and

sow destruction among the colony. A plant pulled up, containing a colony of this species, had almost every one affected, more than half of the colony still clinging to the roots with a wide hole on the abdomen from which the imago had made his escape. One imago was taken apparently busy in laying its eggs in the few still remaining. They were first seen in early part of September, when they were found under almost every plant in the sandy soil along the river, but later on in the fall when the plants had died, I could not find any trace of them, even where they had been very plentiful a short time before.

18. **Aphis frigidæ,** n. sp.

Habit. Found together with *Siphonophora frigidæ* on *Artemisia frigida,* a very characteristic species in some respects, but undoubtedly a true Aphis. So far only the wingless form has been observed.

Wingless form. General color varying from a pale to a rather dark reddish-brown; the whole body being covered by a white pulverulent. The body is also covered by a rather thick pubescence of fine and short white hairs, not seen without the aid of a glass. Head transverse, straight in front; a medio-longitudinal suture is seen from the front of the head running down some distance of the body. Antennæ shorter than the body, sometimes reaching the base of the honey-tubes, on no perceptible frontal tubercles, pale at base, apical half more or less blackish, smooth; I and II subequal and as usual; III, IV and V subequal, or III slightly the longest; VI two-thirds of V; VII the longest, longer than III. Beak rather long and sharply pointed, reaching the third pair of coxæ; first joint pale, second and third black, third very narrow and sharply pointed. Abdomen oval, convex, or in oviparous females the tip is usually much drawn out. Legs rather short, pale except the tips of tibiæ and the tarsi, black; coxæ often also black. Honey-tubes long, reaching tip of the abdomen, longer than the femora, and about three times the tarsi, cylindrical, ending in a very conspicuous round knob, which is as wide again as the width of the honey-tubes. Of a great many specimens examined all presented this character, which as far as I know is peculiar to this species. Color pale and

transparent, or but slightly dusky. Style about as long as the tarsi, cylindrical, rounded at end. Anal plate of oviparous females black and hairy. Length of body .05 to .06.

The habit of this species is more active than any Aphis with which I am acquainted, in this respect coming nearer to Siphonophora.

19. Aphis rumicis, Linn.

Found occasionally on the common dock (*Rumex*).

20. Aphis atriplicis, Linn.

Found on *Chenopodium album*, Linn.

21. Aphis cornifoliæ, Fitch.

This species is rather common on the dog-wood.

22. Aphis setariæ, Thomas.

Found very common on the heads of *Panicum crus-galli*, Linn., and *Setaria glauca*, Beauv. What is apparently the same species was also taken on *Ampelopsis quinquefolia*, Michx.

23. Aphis carduella, Walsh.

Found on *Cirsium lanceolatum*, L.

24. Aphis aparines, Fab.

Found on *Galeum aparine*, Linn., and probably identical with the European species, the plant it inhabits being common to the two continents. But as I have no description of this species as found in Europe, I give one as found here.

Winged form. General color shining black. Head slightly pointed in front. Eyes dark-brown, with a well developed tubercle; ocelli present. Antennæ about as long as the body, black, on moderately developed frontal tubercle, especially as seen from the inner side, where they are slightly gibbous; III long and slightly pale at base, IV and V subequal, VI about one-half of V, VII as long as III or sometimes slightly longer, setaceous; III—V slightly tubercular, cicatrized with small and

irregularly placed spots. Beak moderately long reaching second coxæ. Prothorax with no lateral tubercle, shining black but transversely ridged, with membrane slightly pale; rest of thorax all black. Wings with stigmal vein strongly curved on its basal half; third discoidal obsolete at base; stigma slightly dusky, long and narrow. Legs with the femora pale at base, tibiæ pale except at tip, tarsi all black. Abdomen black. Honey-tubes reaching tip of abdomen, about twice the length of the tarsi, cylindrical, black, ending in a flat rim. Style short. Length of body .06; to tip of wings .12.

Wingless form. General color a dull dark brown or black. Pupæ with the thorax and wing-pads slightly paler, the tip of wing-pads black. From the front of the head there is seen a medio-longitudinal line extending down nearly the whole length of the body. Antennæ reaching the base of the honey-tubes; relative length of the joints as above, but they are smooth and slightly paler; frontal tubercles rather more gibbous. Eyes dark reddish-brown, with a prominent tubercle. Legs and honey-tubes of the same color with the body, or somewhat darker.

This species shows some characters of Siphonophora, but in habit and general appearance is undoubtedly a true Aphis.

IX.—Genus CHAITOPHORUS, Koch.

Head rather broad and straight in front.
Eyes with ocular tubercle; ocelli present.
Antennæ not on frontal tubercles, usually shorter than the body, distinctly pilose or hairy.
Beak moderately long.
Wings as in *Aphis*, but the veins sometimes bordered by black.
Style tubercle-like.
Honey-tubes reduced to mere tubercles, hardly longer than thick, or rarely obsolete.
Body of the apterous form usually tuberculated, and with long slender hairs.
Usually found on the leaves of trees.
Typical American species, *Chaitophorus populicola*, Thomas.

1. Chaitophorus populicola, Thomas.

Found on the under side of the leaves of *Populus monilifera*, Ait.

2. Chaitophorus negundinis, Thomas.

This species is probably one of the most injurious in this locality, the apple plant-lice probably excepted. It is found very common on the box-elder (*Negundo aceroides*, Moench.), caus-

ing the leaves to turn black and become unsightly by puncturing them. During October, when the leaves are falling, the apterous oviparous females can usually be seen in very great numbers around the limbs and twigs busy depositing their eggs around the winter buds and in every crevice, especially on the under side of the limbs, where they can find a safe place to deposit.

3. Chaitophorus nigræ, n. sp.

Habit. Found on the leaves of *Salix nigra* as late as October 26th.

Winged form. Similar to Aphis in general appearance. Entire insect with long white hairs. Head black, rather straight in front. Antennæ about as long as the body, black except base of III; I and II as usual and subequal, III longest, IV a little shorter, V a little shorter than IV, VI about one-half of V, VII as long as IV, setaceous; III—V moderately cicatrized. Eyes dark reddish-brown, with a prominent tubercle. Beak rather short, hardly reaching second coxæ, pointed. Thorax all black, prothorax well developed, pronotum not narrowed in the middle. Wings as usual. Legs with the femora more or less blackish, and the tibiæ pale. Abdomen wholly black or slightly pale, brown along the sides. Honey-tubes tuberculiform, not longer than broad, thickest at base, usually paler than the body. Style tubercle-like, or even knobbed as in Callipterus. Length of body .06; to tip of wings .10.

Wingless form. General color a dull blackish-brown. Body flat, obovate or oblong, quite hairy and tubercular in young specimens, becoming smooth in full grown. Antennæ about one-half the body or a little longer, pale at base, dusky towards the apex; relative length of the joints as in winged form; joints with long white hairs, not very numerous. Abdomen usually with the middle and the margins slightly paler. Honey-tubes as in the above form. Length of body .06.

5. Chaitophorus spinosus, n. sp.

Habit. Found on the under side of the leaves of the oak. A very characteristic and well marked species. The species seems to confine itself to the higher parts of the tree, as I never found

it on the lower limbs that I observed during the summer, where *Callipterus discolor*, Monell, was always found; and it was not until the 17th of October, when several oaks were cut on the campus that I found this species. Only the wingless form has so far been observed.

Wingless oviparous females. Head subquadrate in outline, straight in front, pale red or orange colored, with blackish spines in front and above like those on the abdomen. Antennæ very remote at base, about one-half the length of the body; I and II as usual, III longest, IV a little shorter, V a little shorter than IV, VI hardly one-half of V, VII not longer than VI or shorter; basal joints pale, apical black, with long white hairs as usual in this genus. Eyes large and round, with a distinct tubercle; the facets are reddish-brown, the space between them whitish, giving the eye the appearance of a ripe raspberry just picked with the bloom still on; no ocelli in this form. Beak not more than reaching second coxæ, stout and hairy, pale except at tip; second joint widest. Abdomen widest in the middle, tapering into a very long ovipositor behind, strongly convex above. Color pale yellow, uniformly so on the ventral; last segments sometimes reddish as the head; above with grass-green markings, generally in the shape of a ring, leaving a large patch in the middle of the same color as the abdomen, with projections as follows: one in front, one behind, and two on either side, the one behind reaching down between the honey-tubes. These green markings give an outline somewhat similar to that of a turtle with its head, tail and feet all spread out, but they are sometimes more or less obscure. Above the abdomen has transverse rows of spine-like hairs, black in color and very rigid, usually disposed in groups of one to four, but the spines of each group are rather far apart. The abdomen as well as the entire body has the usual long white hairs of this genus disposed between the spines. Honey-tubes short and thick, about as long as thick, and not quite as long as the tarsi, of the same color with the body. Style short and thick, tuberculiform, hairy. Legs are pale except the tips of the tibiæ and the tarsi, which are black. Length of body .10—.12. As stated above, this form has the abdomen very much drawn out so that the average length of the apterous form probably will not exceed .10.

X.—Genus CALLIPTERUS, Koch.

Head broad and straight in front.
Antennæ not on frontal tubercles, or else on very short ones, seven-jointed; transition from the sixth to the seventh very gradual.
Eyes large and round, with a distinct tubercle, usually of a bright red color; ocelli present.
Beak short.
Wings deflexed; front wings with the stigmal vein much curved, not robust, usually more or less hyaline; cubital vein springing from near the base of the stigma; second discoidal sinuous. Hind wings with two discoidals.
Honey-tubes short, often hardly perceptible.
Style short, enlarged at apex
Body elongate, slender, of very pale colors.
Habit sporadic.
Typical American species, *Callipterus discolor*, Monell.

1. Callipterus ulmifolii, Monell.

Found on the underside of the leaves of *Ulmus americana*, L.

2. Callipterus asclepiadis, Monell.

Very common on *Asclepias cornuti*, L.

3. Callipterus discolor, Monell.

This species together with *Chaitophorus spinosus* are the most common and abundant on the oaks around Minneapolis.

4. Callipterus betulæcolens, Fitch.

Found on *Betula papyracea*, Ait. Dr. Fitch is apparently entitled to this species.

5. Callipterus caryæ, Monell.

On *Carya amara*, Nutt. Very rare as far as observed in this locality.

XI.—Genus LACHNUS, Illiger.

Head small and narrow.
Antennæ not on frontal tubercles, usually quite short, seventh joint not longer than the sixth, and often reduced to a minute spur at the tip.
Eyes large and round, with tubercle; ocelli present.
Beak long and rather slender, extending to and even beyond the posterior coxæ.
Wings with third discoidal twice forked; stigma long and narrow, more of a linear shape; stigmal vein nearly straight or but slightly curved. Posterior wings with two branch veins.
Honey-tubes usually very short, sometimes almost obsolete.
Style obsolete, or very short.
Usually found on branches of trees.
Typical American species, *Lachnus salicicola*, Uhler.

1. **Lachnus salicicola,** Uhler

This is the only species so far observed in this state, yet I do not doubt that most of those found in America will eventually also be found here, as they usually inhabit trees that are common over the greater part of the state. The species has been found very common and abundant on several varieties of willow from early May to late in November. Once also taken on the young twigs of a poplar (*Populus*). In early spring especially they exude very abundantly a clear watery fluid, but it seems not to have that sweet quality usually found in the family of plant-lice, as no ants were ever observed to feed on it. On being crushed they stain the hand a deep red.

The eggs are laid in October and November on the limbs, and especially around the winter buds.

XII.—Genus MASTOPODA, g. nov.

Head transverse, rounded in front.

Antennæ on no frontal tubercles, remote at base; about as long as the body; six-jointed (very probably by the union of the third and the fourth); the third and setaceous seventh longest.

Eyes with inconspicuous tubercle; ocelli present.

Beak long, reaching third coxæ.

Wings as in Aphis, but the venation quite variable.

Legs moderately long; tibiæ all truncated at the tip, and with rudimentary tarsi, only a short mammiform tubercle with no claws, takes the place.

Honey-tubes moderately long, cylindrical.

Style short and tubercle-like.

Found in large colonies as Aphis.

Typical species, *Mastopoda pteridis*.

The anomalous species for which this genus has been erected will not fall into any of the genera so far as known to me. In size, form and habit, it comes nearest to *Aphis*, and as to the six-jointed antennæ it could be put in *Sipha* together with *Sipha rubifolii* of Doctor Thomas. But the peculiar form of the tibiæ and the rudimentary tarsi will exclude it from either. I confess that I am unable to account for this peculiar structure, or what importance should be assigned to it. There seems to be nothing analogous to it either in this family or order of insects under consideration.

Although the form of the antennæ will put it in the section *Lachnini* I think it could be put in *Aphidini* with as much pro-

priety, especially if we take into consideration the setaceous and long character of the last joint, and the probable union of the third and fourth joint forming the third in this species.

1. **Mastopoda pteridis,** n. sp.

Habit. Found in large colonies on the underside of the fronds of *Pteris aquilina,* L., or common brake.

Winged form. Head transverse, rounded or slightly pointed in front as in Aphis, flat above with a slight impression in the middle, black or blackish. Eyes dark-brown; the ocular tubercle hardly perceptible; ocelli present and conspicuous, bordered by a ring of deeper black. Antennæ not on frontal tubercles, remote at base, about as long as the body; 6-jointed, black; I and II subequal and slightly narrower at base; III very long and thick, narrow at the insertion with II, longer than IV and V together; IV about one-half of III, similar to it; V short about one half of IV, narrower and smooth; VI long and setaceous, usually as long as III. Beak long, reaching third coxæ, pale except at tip. Pronotum of the prothorax narrowed in the middle, with no lateral tubercle, black or blackish with the membrane greenish. Thorax all black, slightly shining. Wings as in Aphis, but the venation varies a great deal; third discoidal obsolete at base; second branch about as far from the margin as from the origin of the first; second pair of wings with two discoidals, but the second sometimes obsolete, and with two rather long and slender hooklets. Legs pale brownish or more or less dusky with only the tips of tibiæ quite black; tibiæ are rather long and somewhat enlarged at the tip, which is truncated and apparently hollow and with no tarsi proper; a short mammiform tubercle, rounded at end, with no claws, from the inner side of the hollowed tibiæ is all that can be found as a rudimentary tarsus. I have examined a great many specimens in all stages and at different times, but have not found the slightest variation in this respect. Apparently they walk on the perpendicular surface of glass with more ease than any other species in this family. Abdomen pale green or yellowish-green, more or less dusky in the middle, sometimes forming a well defined subquadrate patch; ventral uniformly pale. Honey-tubes compara-

tively long, about as long as the distance between them, cylindrical, dusky or black. Style very short and tuberculiform, hairy, concolorous with body. Anal plates hairy; the upper transverse and usually pale, the lower concave on the inner side and usually dusky. Length of body (males) .05 to .06; to tip of wings .10 to 11.

Apterous forms. The pupa-form is very conspicuous by its reddish-yellow head and thorax, the abdomen being pale yellow; tip of wing-pads pale. Antennæ as in foregoing form, reaching honey-tubes. Eyes large, but the tubercle is not very conspicuous; ocelli rudimentary as brown spots. Honey-tubes reaching tip of abdomen, usually pale, sometimes dusky. Legs pale; tarsi rudimentary as above. Larvæ are slightly smaller, pale yellow, with tortoise-shell markings on the abdomen. Legs and honey-tubes pale. Length of pupa .07. Length of larvæ .05.

The venation of this species probably varies more than in any other so far as known. I give the result of 14 specimens taken at chance and examined in reference to this.

Six had both wings normal.
Three had one wing normal and the other with the third discoidal but once branched.
One with the stigmal vein nearly straight in both, and with one-half of the second forkal obsolete in one of the wings.
One specimen with the second branch obsolete in one of the wings, and the same rudimentary in the second.
One specimen with one wing normal; the second with the forkal of the first branch rudimentary.
One specimen with the stigmal vein in one of the wings once-branched.
One specimen with the third discoidal three times branched in one of the wings, and the stigmal vein once.

XIII.—Genus SCHIZONEURA, Hartig.

1. Schizoneura americana, Riley.

Found on the white elm (*Ulmus americana*, L.,) causing the leaves to curl and become disfigured. Very common especially on young trees.

2. Schizoneura panicola, Thomas.

This very peculiar species, from its inhabiting the roots of grasses, is found rather common in this locality on ***Panicum glabrum***, L., ***Setaria glauca***, Beauv., and ***Eragrostis pectinacea***,

var., *spectabilis*, Gray. The winged form was observed plentiful September 20th. Ants were generally found to herd this species.

3. **Schizoneura querci,** Fitch.

What was taken to be this species was taken on oak, but only apterous form so far seen.

XIV.—Genus COLOPHA, Monell.

1. **Colopha compressa,** Koch.

The cock's-comb gall of the white elm. (*Ulmus americana*, L.) So far I have not found it very common in this locality.

XV.—Genus PEMPHIGUS, Hartig.

1. **Pemphigus populicaulis,** Fitch.

Found rather common on *Populus monilifera*, Ait. I have also this species from Nicollet county.

2. **Pemphigus populi-transversus,** Riley.

Like the last found on *Populus monilifera*, Ait. along the river-bank. Sometimes the two were taken together on the same tree.

3. **Pemphigus vagabundus,** Walsh.

The unsightly black galls of this species too often disfigure the poplars in and about Minneapolis as they remain over winter. Young trees seem especially to be effected, and often almost every twig ends with one of these galls.

4. **Pemphigus rhois,** Fitch.

Found rather sparingly on *Rhus glabra*, L.

XVI. - Genus TYCHEA, Koch.

1. Tychea radicola, n. sp.

A few very peculiar specimens were found on the roots of *Ambrosia trifida*, L., September the 14th, but as I did not succeed to find it again, I am not quite satisfied as to its generic position. I will give my notes as taken at the time.

Apterous form. Head nearly as broad as long, rounded in front; two small spots of black, these probably are rudiments of eyes. Antennæ 5-jointed (or 6-jointed counting the spur on the last as one), pale or only slighty dusky towards the tip; I and II short and subequal, III longest and about as long as the two first, IV but a little shorter, V as long as III counting the spur, or else about as long as IV; smooth, or with a few short and slender hairs near the apex of each joint. Beak very long reaching to the middle of the abdomen; first joint longest reaching slightly beyond the third coxæ, second short, last but a little longer than second, gradually narrowed to a point but not sharply so; two last joints slightly dusky. Abdomen suborbicular, very convex above, color whitish (as is the whole insect), the margin with a row of small tufts of white flocculant matter. No honey-tubes apparent. Style short, globular, with some rather long and curved hairs. Length of body .06.

The University of Minnesota, Dec. 1, 1885.

III.

REPORT ON THE LOWER SILURIAN BRYOZOA WITH PRELIMINARY DESCRIPTIONS OF SOME OF THE NEW SPECIES.

By E. O. ULRICH.

The bryozoa are unusually abundant in the Lower Silurian strata of Minnesota. This is especially true of the Trenton shales, in which they constitute about two-thirds of the entire fauna. Many of the species are extremely abundant, and the thin slabs of limestone are largely composed of their fragments. The shales immediately succeed the "Buff limestone," in which but few remains of this class of fossils occur. Those observed, moreover, are so badly preserved that it was found impossible to determine the species. Just below this limestone and resting on the St. Peter sandstone, is found the building stone commonly used at Minneapolis. This limestone does not appear to belong to the Trenton group, and, judging from the fossils, seems rather to indicate an equivalence with the Chazy, or, perhaps, Black River. These strata are not present in the sections studied in Wisconsin and Illinois, where the "Buff limestone" rests on the St. Peter sandstone, but at High Bridge, Ky., they are represented by a mass of rock several hundred feet in thickness. The beds in the neighborhood of Lebanon, Tenn., seem to belong to the same age. The shales which are here called Trenton, are assigned in some preceding reports to the "Hudson River" group, but the fossils contained in them, notably the bryozoa, show conclusively that that is not their true position. Of the eighty-three species of bryozoa obtained from them, no less than twenty-five are identical

with species occurring in the Trenton of New York, Canada, and Tennessee. That they really belong to the Trenton is further shown by the fact that they are superseded by the Galena.

In the following list are noted all the species so far studied. More extended investigations will, I do not doubt, swell the number some twenty or thirty more. Because of other engagements I did not have the time required to write out descriptions of all the new species, but this is scarcely a cause for serious regret, since the survey proposes to publish, at an early date, full descriptions and illustrations of all the species found in the state.

BERENICEA MINNESOTENSIS, n. sp.

Zoarium attached to foreign bodies, consisting of extremely thin patches, irregular in outline. Zooecia partially immersed, the exposed portion appearing as broadly-elliptical convex spaces, about 1-95th of an inch in their longest diameter. Apertures somewhat oblique, contracted, circular, 1-200 of an inch in diameter, and surrounded by a barely perceptible rim or peristome. The arrangement of the cells is usually more or less regular in curved diagonal lines; not infrequently, however, the specimens show considerable variation in the number occupying a given space, while here and there, a small non-celluliferous spot may be detected. From six to nine may be counted in the length of .1 inch, but the average number is about seven.

The relations of this species appear to be almost exactly intermediate between the two Cincinnati group species *B. primitiva* and *B. vesiculosa*. From the former it differs in having its cells less immersed, and the apertures less prominent but more distinctly contracted. In distinguishing *B. minnesotensis* from *B. vesiculosa*, the same differences become apparent, but reversed in their application.

Formation and locality: Not uncommon in the shales of the Trenton group, at Minneapolis, Minn.

Register No. 5925.

ROPALONARIA PERTENUIS, n. sp.

Zoarium adnate; cells uniserial, very elongate-elliptical, about four in the length of .1 inch; from the proximal end, which is very slender and always more so than the anterior, the cell gradually increases in size until at the center or some point nearer the anterior end, it has assumed a diameter of about 1-130th of an inch. This point is marked by the presence of the subcircular aperture, which is surrounded by a very faint peristome, and has a diameter of less than 1-200th of an inch. At every fourth or fifth cell the series bifurcates; this cell is more abruptly swollen and larger than those intervening, while it differs still further in having its aperture situated quite near the anterior end.

This species is closely allied to the *Stomatopora* (*Ropalonaria*) *elongata*, Vine, from the English Wenlock deposits. Its relation to the type of the genus, *R. venosa*, Ulrich, from the Cincinnati group of Ohio, is however, still more intimate. The former it resembles in its growth, and the latter in the shape of its cells.

Formation and locality: Rare in the Trenton shales, at Minneapolis, Minn.

Register No. 5926.

HELOPORA DIVARICATA, n. sp

Zoarium segmented; segments cylindrical, poriferous on all sides, obtusely pointed at each end, and varying in length from two to four-tenths of an inch; their diameter varies between .02 and .03 inch. Zooecial apertures oblique, ovate, spreading anteriorly, and arranged in troughs between strong longitudinal ridges, six in the length of .1 inch. Passing around and forming the posterior border of the aperture is a faint ridge that on each side is obliquely directed across the longitudinal keels, where it meets a similar line proceeding from one of the cells in the adjoining series. These divaricating lines give to the strong vertical ridges the appearance of being marked by a succession of Λ-shaped furrows and elevated lines. Eight or nine rows of cells suffice to pass around a segment.

Beyond the fact that the zooecia are tubular and radiate in all directions from a central axis, the internal structure is unknown.

This species is clearly congeneric with *Helopora fragilis*, Hall, and *H. spiniformis*, Ulrich. The last species was originally placed by me in the genus *Arthroclema* of Billings.* At that time I had not yet succeeded in obtaining satisfactory sections of the type species of *Helopora*. Through the kindness of Mr. Arthur H. Foord, who sent me better material of the species than I had yet seen, I have since been enabled to work out its structure. In nearly all respects it is identical with that of *H. spiniformis*. This being the case, the question whether *Arthroclema* could be distinguished from *Helopora* by characters of more than specific importance at once presented itself. While I am not yet prepared to assert that the differential characters observed are really of generic value, still I believe that, provisionally, the best plan is to keep them separate. One of the most striking external features of the three species of *Helopora* now described, and two other species known to me, is found in the arrangement of the zooecial apertures between vertical ridges. These ridges are not obvious in the Canadian specimens of *Arthroclema pulchellum*, nor in the Minnesota examples at present doubtfully identified with that species. Instead, we find two or three more or less flexuous lines and grooves marking the inter-zooecial spaces. A more important difference is found in the reproduction of the segments. In the species of *Helopora* this is only terminal; while in *Arthroclema pulchellum* it is both terminal and lateral, there being two "sockets" situated just opposite each other on the opposite sides of each of the main segments for the articulation of the smaller lateral branches. The form of zoarium resulting from this mode of growth resembles that of a feather in having a strong central rib and more slender lateral branches. On the other hand. the mode of growth of *Helopora* seems to be precisely like that of *Arthronema*, Ulrich, in which each segment gives off from its upper termination one or two similar joints, Whatever course may be finally adopted in the disposition of *Helopora* and *Arth-*

*Amer. pal. bry., Jour. Cin. Soc. Nat. Hist., vol. v. p. 161. pl. 6, fig 10, 1 a, 10b.

roclema, enough of their structure is known to make their reference to the fam. *Arthronemidæ* almost unquestionable.

Specifically, *H. divaricata* is distinguished from *H. spiniformis* by its slightly larger cells, more distinct longitudinal ridges, and their peculiar ornamentation.

Formation and locality: Rather rare at the base of the Trenton shales, at Minneapolis, Minn.

Register No. 5928.

PHYLLOPORA? CORTICOSA, n. sp.

Zoarium flabellate to funnel-shaped, undulating and irregular in growth, composed of anastomosing branches having a width varying from 0.015 to 0.035 inch. Poriferous side presenting the appearance of a *Fenestella* with carinate and more or less rigid branches, and much depressed dissepiments. On each side of the sharp and usually spiniferous median ridge, there are two rows of rather irregularly alternating circular cell-apertures, thirteen or fourteen of which occur in the length of 0.1 inch. The depressed dissepiments are short and carry two or three rows of cells. In rare instances this division of the frond into rigid branches and dissepiments is not recognizable. In such fragments, or portions of elsewhere normally constructed specimens, the branches anastomose rather irregularly and are simply convex, not carinate, the median ridge being apparently absent. Branches on the non-celluliferous side of frond faintly striated, and tending, though not so obviously as on the poriferous face, to form longitudinal ridges. Fenestrules varying in outline from elongate-elliptical to sub-circular, with a width rarely more, usually a little less than that of the branches, and a length from one to three times the width. Measuring transversely, from six to eight occupy 0.2 inch; longitudinally, from two and a half to four occur in the same distance.

Tangential sections, cutting the frond through the plane of its expansion and near the middle of its thickness, show that the branches are divided into approximate halves by an obscurely double wall, thicker than those of the tubes, diverging from it toward each side. The tubes have thin walls, are long,

and divided by distinct straight diaphragms in their outer portion. Where the section divided the tubes just below their apertures they are seen to be subcircular, with slightly thickened walls, and partially separated from each other by angular interstitial or abortive cells, that may be considerably smaller or even a little larger than the true zooecia. Here and there, along the middle of the branch, one of the spiniform tubuli may be detected.

Vertical sections show that the zooecial tubes also arise from a thick basal membrane, from which they diverge in an upward and outward direction, that their approach to the celluliferous surface is very gradual in the lower half of the branch, and somewhat less so in the upper half. Here they are crossed by two or three unmistakable diaphragms, and their number increased by gemmation. These shorter tubes I am inclined to regard as representing the angular interstitial (abortive?) cells noticed in describing the tangential section.

In transverse sections the branches are sub-rhomboidal, the lateral diameter being the shortest. The median ridge is represented by an obscurely double vertical wall, dividing the branch into two nearly equal portions. Between the two laminæ forming this wall I can detect a series of very minute tubuli, such as are found between the median laminæ of many of the *Stictoporidæ*. The lateral portion of the circumference of the cells, (*i. e.* the half directed toward the sides of the branches,) is rounded or semi-circular, while the opposite half is wedge-shaped.

This species, though in many respects very peculiar, is unquestionably allied to such bryozoa as *Intricaria reticulata*, Hall, *I. clathrata*, S. A. Miller, *Retepora trentonensis*, Nicholson, *R. angulata*, Hall, *R. asperatostriata*, Hall, and *Phyllopora variolata*, Ulrich. These species are all congeneric, but there is no established genus to which they can be referred with certainty. In an earlier writing* I placed two of the species in King's genus *Phyllopora*, but, at present, I am inclined to believe that the type of that genus will prove to be quite a distinct form. Judging solely from Prof. King's figures and description the affinities of *P. ehrenbergi* seem to be not far

*"Amer. pal. bry." Jour. Cin. Soc. Nat. Hist. vol. v, p. 160.

removed from *Polypora*, McCoy, and *Lyropora*, Hall. Should this be the case, then it would be necessary to establish a new genus for the reception of the species above cited, as their relation to those genera is only very slight. In fact, I doubt that their peculiarities of structure will admit of their being arranged in the same family. Still until something further is learned of the structure of *P. ehrenbergi*, I have concluded to defer the erection of a new genus, and will, provisionally classify them with *Phyllopora*, adding the usual question mark.

Specifically, *P.? corticosa* is readily distinguished from other species of the genus, by the carinated character of the branches. A species, at present doubtfully identified with *P.? trentonensis*, Nicholson, occurs in what is called the building rock. These beds are the same as those occurring in the gorge of the Kentucky river at High Bridge, Ky., and at Lebanon, Tenn., and most probably represent the Chazy. The *P.? reticulata*, Hall, is quite common in the Trenton shales at Minneapolis.

Formation and locality: Trenton, at Oxford mills, Cannon Falls, Goodhue Co., Minn., where it is associated with *Streptelasma corniculum*, Hall, *Prasopora conoidea*, n. sp., and other fossils characteristic of the Trenton shales about Minneapolis.

Register No. 3495.

PTILODICTYA SUBRECTA, n. sp.

Zoarium consisting of an unbranched, flattened, two-edged, straight or slightly curved frond, that gradually expands from the acutely-pointed articulating "head" upward from 0.2 to 0.5 of an inch, the edges of the rest of the frond being parallel, or nearly so. The greatest width varies in different examples from 0.05 to 0.15 of an inch. The total length is generally about one inch, though it is not uncommon to find specimens of nearly twice that length. The thickness rarely exceeds 0.04 inch. Cells rhomboidal, with acutely-elliptical apertures, arranged in intersecting diagonal lines, the regularity of which is sometimes interrupted along the narrow, but distinct non-poriferous margin, where they are slightly larger than over the central portions of the frond, and have a tendency to form

longitudinal series. For a short distance above the pointed basal termination the zoarium is sub-cylindrical, and the cell apertures, being extremely elongated and apparently confluent, give this portion the appearance of being finely striated. Measuring diagonally, eleven cells occur in the length of 0.1 inch; transversely sixteen, and longitudinally six, occupy the same space.

This form takes the place of P. (*Escharopora*) *recta*, Hall, in the western exposures of the Trenton group. It is quite rare in Kentucky and Tennessee, but common in Minnesota. If I am right in my identification, it also occurs in the lower beds of the Cincinnati group (Utica shale?) in Ohio. Its geological and geographical ranges are therefore quite extended, and make it desirable that it should be held as distinct, although it is, unquestionably, very closely allied to both *P. recta* and *P. falciformis*, Nicholson. It is narrower and generally smaller than either of those species, while its nearly straight form and more acute basal termination will serve to distinguish it from the latter. The type specimens of *P. recta* are sub-cylindrical, but should this peculiarity prove to be due to extreme age, then the points of difference between the three forms would be reduced to less than specific importance, in which event I should classify them as varieties of the same species.

The genus *Ptilodictya* as defined by me, naturally divides into two groups: (1) the section containing the type species, *P. lanceolata*, Goldf., in which the cells have a plumose arrangement; and (2) another section containing the three species or varieties in question, in which the cells are arranged in intersecting diagonal series. The first or typical section of the genus commences its existence near the top of the Cincinnati group, when the second section has become about extinct, and is best represented in Upper Silurian deposits. That its species are, however, direct descendants from those of the second section, cannot be doubted; *P. plumaria*, James, (as fig. by Ulrich), and *P. magnifica*, S. A. Miller, being clearly transitional forms. Should it become desirable to separate the two groups, Hall's genus *Escharopora* would include the second section.*

* The Lower Helderberg species referred to, *Escharopora*, by Hall are unequivocal members of the typical section of *Ptilodictya*.

Formation and locality: A common species in the Trenton shales, at Minneapolis, and other localities in Minnesota. It also occurs in the Trenton limestone of Kentucky and Tennessee.

Register No. 5929.

ARTHROPORA SIMPLEX, n. sp.

Zoarium jointed, segments fragile, unbranched, acute-eliptical in transverse section, from 0.4 tŏ 0.7 inch long, from 0.04 to 0.07 inch wide and not ceeeding 0.04 of an inch in thickness. The first segment is sometimes irregularly branched, but that condition does not appear to be normal. The base of this joint is obtusely pointed and striated, the striae extending above the articulating shoulder one-tenth of an inch or more. The extremities of the succeeding segments are smooth or faintly striated, and slightly swollen. Zooecial apertures, of the younger segments, with the margin distinctly elevated so as to leave a narrow interstitial sulcus between them. Their arrangement is very regular in transverse and intersecting diagonal series; transversely, seven occur in 0.05 inch; diagonally, five occupy the same space; width of interstitial space less than the shortest diameter of the apertures. Non-poriferous margin narrow und obliquely striated. On the older and especially the first segments, the cell-apertures are smaller and circular, and the width of the interstitial spaces from one to three times their diameter, the non-poriferous margin wide, and the whole inter-apertural space marked with fine, flexuous, and faintly granular striae.

In tangential sections the cells are oval, thick-walled, and each surrounded by one or two rows of very minute tubuli.

On account of the condition of the specimens, both the vertical and transverse sections are unsatisfactory.

This species clearly belongs to the genus *Arthropora*, and in the structure and appearance of its cells, differs but little from *A. shafferi*, Meek. The unbranched condition of the segments, however, will distinguish *A. simplex* from that species as well as from any other form of the genus known to me.

Formation and locality: The detached segments of this spec-

ies are very common in the Trenton shales, at Minneapolis and other localities in the state where these beds are exposed. Segments of the Trenton variety of *A. shafferi* are also, though rarely, met with.

Register No. 5933.

STICTOPORA MUTABILIS, n. sp.

Zoarium variable in size and superficial aspect. Typically, it consists of branches dividing dichotomously at intervals of 0.3 to 0.4 of an inch; width of branches varying from 0.10 to 0.18 inch; thickness of same, from 0.03 to 0.06 of an inch; edges somewhat acute, with non-poriferous margin very scant, or wanting. Cells arranged in from sixteen to twenty-five rows, between rounded and but slightly elevated longitudinal lines; walls thick, apertures small, narrow, elliptical.

In old examples the apertures are scarcely recognizable, the surface appearing as simply striated. Measured transversely, sixteen rows occupy the space of 0.1 inch; longitudinally, seven and a half or eight cells suffice to fill the same space.

Sections show that the walls are extremely thick, that they are divided into longitudinal series by straight rows of very minute but distinct tubuli, and that a variable number of the latter also occur between the ends of the cells. In transverse sections these tubuli are quite conspicuous between the median laminæ of the zoarium. In vertical sections, the spur or diaphragm occurring at the base of the thick portion of the tube walls, gives to the lower region of the zooecia the form of a semi-circle.

The above sufficiently describes the typical form of this species. The two extremes of variation may be designated, provisionally, as varieties *major* and *minor*.

Var. MAJOR, n. var.

The zoarium of this variety differs from the typical form of the species in having a more robust appearance. The branches attain a width of 0.3 inch, and a thickness of 0.12 inch. Along

the center of the branches, at rather irregular intervals, occur finely striated non-celluliferous spots, which tangential sections show to be occupied by an aggregation of the minute tubuli. The rows of cells in the neighborhood of the edges of a branch are usually directed obliquely outward.

Var. MINOR, n. var.

This variety is distinguished by its smaller size, thinner branches, and more distinctly developed non-poriferous margin. Its branches vary in width from 0.07 to 0.10 inch, while the thickness rarely exceeds 0.02 inch.

This species, as well as the two species next described, are congeneric with *Rhinidictya nicholsoni*, Ulrich. When I proposed the genus *Rhinidictya*, it was under the impression that Hall's *Stictopora fenestrata*, the type of the genus, was closely allied to his *S.? acuta*. Although I have failed in obtaining authentic examples of *S. fenestrata* for comparison, I am, nevertheless, convinced by the study of specimens identified with that species from the Chazy limestones of Kentucky and Tennessee, that I was in error, and that the species is really more nearly related to my *R. nicholsoni*. The name *Rhinidictya* may therefore be erased from the list of genera, while *Stictopora* must be re-defined and restricted so that it will cover about the same ground lately occupied by the abandoned genus. In its restricted sense, *Stictopora* is typified by *S. fenestrata*, Hall, *S. mutabilis*, Ulrich, and *S. nicholsoni*, Ulrich. The cells of *S.? acuta*, Hall, and its near ally *Ptilodictya fenestelliformis*, Nicholson, have the structure of *Pachydictya*, Ulrich, to which genus I now refer them.

In the upper shaly layers of the Kentucky exposures of the Trenton group, *S. mutabilis* is a common fossil, but the two varieties, *major* and *minor*, seem to be peculiar to the Minnesota beds. Young specimens are not readily distinguished from *S. nicholsoni*, but there is no difficulty in separating the fully matured examples, the cell walls being thicker and the branches larger and much heavier than in that species.

Formation and locality: Extremely abundant in the Trenton shales about Minneapolis, and St. Paul, Minn.

Register Nos. 5938, 5939, 5956.

STICTOPORA FIDELIS, n. sp.

Zoarium branching dichotomously at intervals of about 0.5 inch. Branches from 0.08 to 0.11 of an inch in width; thickness of same varying from 0.03 to 0.06 of an inch; edges less acute than usual; non-poriferous margin narrow. Zooecia with comparatively thin walls and slightly oblique, sub-ovate or quadrangular apertures, arranged in from nine to twelve longitudinal series, between sharp though but slightly elevated lines. Measured longitudinally, eight or nine cells occur in the length of 0.1 inch; transversely, six or seven rows occupy 0.05 inch.

In tangential sections dividing the cells just below their apertures, the cell walls are rather thick, and the tube cavities elliptical, while the longitudinal elevated lines of the surface are represented by a straight dark line. A good section will show this line to contain a series of very minute tubuli, the same as occur between the divisional laminæ of the two sides of the zoarium. At a lower level in the zoarium the cells are subquadrate near the center, and rhomboidal toward the edges of the branch; the walls are thin, the anterior one convex.

Longitudinal sections show that the tubes arise abruptly from the divisional laminæ on each side, and that their course to the surface forms an angle with the median line of about 55 deg.; the anterior side of the walls is concave in the lower portion, while the posterior side is nearly straight throughout. A complete or only partial diaphragm is occasionally developed at the termination of the concave portion of the cell wall.

This species is distinguished from *S. mutabilis* by its slightly wider cells and comparatively thin walls. The cell apertures are consequently much larger than they are in that species, being besides nearly quadrangular instead of narrow-elliptical. Sections show *S. fidelis* to be clearly distinct from, though allied to *S. nicholsoni*, Ulrich.

Formation and locality: Not uncommon in the Trenton shales at Minneapolis, Lanesboro, and other localities in Minnesota.

Register No. 5936.

STICTOPORA PAUPERA, n. sp.

Zoarium small, fragile, very slender below, where it is attached to foreign bodies by a rather dimunitive basal expansion; above this it gradually expands until at a distance of about 0.3 of an inch above the base, it has attained its mature width, varying in different examples from 0.06 to 0.09 of an inch; here also occurs the first bifurcation, the second occurring about 0.25 inch above the first, while a third division, at nearly the same distance from the second, is occasionally met with. The entire hight of the zoarium is, therefore, rarely more than one inch. The greatest thickness does not exceed 0.02 of an inch. The angle of bifurcation is about 70 degrees, and quite the same in all the specimens. Cells with small, narrow, elliptical apertures, arranged in from ten to twelve longitudinal series, between slightly elevated lines; the cells in one or two of the outermost rows are directed obliquely outward. Measuring longitudinally, nine cells occupy the space of 0.1 inch; transversely, eight rows occur in 0.05 inch. Non-poriferous margin very narrow, only recognizable in good specimens.

This species is also a common fossil in the shaly layers of the Trenton group in Kentucky, where it is associated with *S. mutabilis* and other bryozoa marking this horizon. It also occurs in the Trenton rocks of Canada. The small size of its zoarium will distinguish it from other species of the genus.

Formation and locality: Trenton shales, at Minneapolis and other localities in Minnesota.

Register No. 5935.

STICTOPORELLA? CRIBROSA. n sp.

Zoarium forming thin flattened expansions, composed of branches which inosculate at short intervals till there is produced a broad frond perforated at rythmical intervals by circular or elliptical fenestrules. Both sides of frond celluliferous and consisting of two equal layers of cells that have grown together back to back, each layer, however, preserving its own concentrically striated epithecal membrane. Fenestrules usually inclined to be elliptical, their longest diameter varying

from 0.03 to 0.10 of an inch, but the prevailing size has a diameter of about 0.06 inch. Width of branches about 0.09 inch; thickness of same, varying from 0.02 to 0.06 inch. Zooecia with subcircular or broadly ovate apertures, arranged in quite regular diagonal series, nine or ten in the space of 0.1 inch. Interstitial spaces becoming thicker with age, till the zooecial apertures are separated by a distance a little greater than their diameter. Interstitial pits numerously interpolated between all the cells. Around the fenestrules there is a band 0.02 of an inch, more or less, in width, solely occupied by them.

Tangential sections show that the polygonal boundary of the zooecia is marked by a dark line, which, the evidence at hand, is not clear enough to prove to have contained a series of extremely minute tubuli. The visceral cavity is small, ovate, or subcircular. The interstitial pits are numerous, of irregular shape and unequal dimensions, often completely filled, or only preserving a very small central cavity.

Vertical sections show that the divisional laminae are flexuous, that the tubes are at first thin-walled and prostrate, that they subsequently bend abruptly outward, and that their walls at the same time are much thickened and marked with oblique lines parallel with the form of the apertures. The interstitial pits, wherever observed, were entirely filled by a concentric deposit of sclerenchyma. No diaphragms appear to have been developed.

The cells of this, and the two species next described, in all the essential points of structure, are precisely like those of *Stictoporella interstincta*, Ulrich. The characters of the genus as typified by that species, are entirely peculiar, and bear but little resemblance to those of *Stictopora*. In fact, so far as the microscopic structure is concerned, *Stictoporella* is more nearly allied to *Ptilodictya* than to *Stictopora*, but whether the peculiarities of the genus will necessitate a removal from the family *Stictoporidae*, I am not yet prepared to assert. At any rate, the structural distinctness of the genus is firmly established by the addition of the three species in question. A most striking peculiarity is presented by these species. I refer to the great difference in the form of the zoaria, when compared

with the remarkable similitude of the internal structure. Indeed it is highly improbable that any one, giving them only a superficial examination, would have classified them as nearly related species. Sections, however, prove beyond any reasonable doubt that their relation to each other is really very intimate, although distinguished from each other by very obvious differences in their respective methods of growth.

An inosculating bryozoan has been described by Hall from the Trenton rocks of Wisconsin, under the name of *Clathropora flabellata.* The description and figures are both entirely inadequate for anything even approaching a positive identification. This style of zoarium pertains to at least three Palaeozoic genera, and the species might belong to any one of these. That the species which I have above described is distinct from Hall's species is evident. His figure represents a more robost zoarium, the branches and fenestrules being over twice as wide as those of *S. cribrosa.*

Formation and locality: Abundant in the Trenton shales at Minneapolis, Minnesota.

Register No. 5944.

STICTOPORELLA ANGULARIS, n. sp.

Zoarium dividing dichotomously at intervals varying from 0.15 to 0.30 of an inch. Branches usually about 0.08 of an inch in width; frequently they are narrower, while on the other hand, a single fragment apparently referable to this species is twice as wide. The thickness is generally about 0.03 inch, and never, so far as observed, exceeds 0.05 of an inch. Transverse section of branch elliptical, the margins being rarely acute, and usually rounded. Cells polygonal or sub-rhomboidal, with sub-circular apertures placed at the bottom of a sloping "vestibule," arranged in somewhat irregular intersecting diagonal series, nine in the space of 0.1 inch; measured longitudinally, seven and one-half cells occupy the same space. Here and there over the central portions of the branch, though never in sufficient number to constitute a conspicuous feature, may be detected an interstitial pit. On the rounded margins of the zoarium, however, they are always present.

Here they form a series on each side of the median laminae. Sometimes they are very shallow and obscured by a secondary deposit of sclerenchyma.

In tangential sections, the visceral chambers of the zooecia are oval, the interspaces thick and divided in the middle by a thin, sharply defined, dark line, marking the boundary line between adjoining cells. Each cell somewhat irregularly hexagonal. A few interstitial pits, here entirely filled by sclerenchyma, may be detected.

Vertical sections demonstrate that the tubes are at first prostrate and with thin walls. At the point of bending outward in their course to the surface, the walls suddenly become very thick and marked with oblique lines, representing the form of the campanulate aperture at previous stages of growth. Diaphragms have not been observed.

The angularity of the cell apertures sufficiently separates this species from *S. interstincta* from the Cincinnati group, while the same character, and the diagonal arrangement of the cells, will serve to distinguish it from a the species of *Stictopora* occurring in the same beds. It cannot be confounded with its much larger and nearest ally *S. frondifera*.

Formation and locality: Not uncommon in the Trenton shales at Minneapolis, Minn., but apparently restricted to the lower portion.

Register No. 5943.

STICTOPORELLA FRONDIFERA, n. sp.

Zoarium, consisting of large, thin, irregularly branching, flabellate or undulate expansions, which are celluliferous on both faces, and have rounded and minutely pitted margins. Cells arranged more or less regularly in diagonally intersecting series nine or ten in the space of 0.1 inch. The cell apertures vary from sub-circular to sub-rhomboidal. Interstitial spaces rather thick. Interstitial pits, variously distributed among the zooecial apertures, or aggregated so as to form clusters or "maculæ." These clusters are always quite irregular in both size and distribution. Thickness of frond apparently never exceeding 0.10 inch; usually it is not more

than half that thickness. Entire hight of zoarium three or four inches.

The sections of this species are almost exactly like those of *S. angularis,* and do not require a detailed description. One of the tangential sections, however, shows clearly that the boundary line between adjoining cells is occupied by a closely arranged series of very minute tubuli. The evidence afforded by the sections of *S. angularis* and *S. cribrosa* is not sufficiently clear to allow me to assert positively that these tubuli are also present in those species, but that they are is highly probable.

Formation and locality: Rather abundant in the lower part of the Trenton shales at Minneapolis, Minn. It also occurs at Lanesboro and Fountain in Fillmore county.

Register Nos. 5945–5947.

PACHYDICTYA FOLIATA, n. sp.

Zoarium growing from an attached basal expansion into erect, thin, undulating and often palmate fronds, both sides of which are celluliferous; the hight and width may be two inches or more, though it is rare to find specimens more than one inch square; their thickness is usually about 0.05 of an inch; very old examples may attain a much greater thickness, it being in some not less than 0.13 inch. Margin of fronds acute, and always more or less distinctly non-poriferous. Cell apertures large, oval, and arranged in regular intersecting series, in which six or seven occur in the length of 0.1 inch. Measuring longitudinally (*i. e.* across their larger diameter) four or five occupy the same space. On a few specimens the zooecial apertures are surrounded by a thin rim or peristome. This feature may indicate a particular stage of development, or only an exceptional state of preservation. Inter-apertural space only moderately thick, generally smooth, it being only in rare instances that the really numerous interstitial cells can be detected at the surface. At intervals of about 0.15 of an inch the surface presents smooth spots or maculæ. Usually, these are not elevated above the general plane of the surface, but in a few cases they are rather prominent.

In vertical sections the tubes arise somewhat abruptly from the median laminæ, near which their walls are thin. The interstitial tubes are developed almost immediately, and in their lower portion are crossed by numerous very distinct diaphragms, that, as the surface is approached become entirely obsolete, or at least much obscured by a deposit of sclerenchyma. In the "maculæ" which contain only interstitial tubes, the diaphragms are decidedly vesicular. The true zooecia are crossed at intervals about equalling their diameter, by from two to four complete diaphragms. These recur at about the same level in all the tubes.

In tangential sections near the central axis, the zooecia have thin walls, are broadly ovate, and more or less completely separated from each other by a series of angular interstitial cells. Nearer the surface the walls of the tubes become thickened and ring-like, but the original boundary remains distinct as a sharply defined dark line. Within this line there is a series of extremely minute tubuli. Just below the surface of fully matured examples the "maculae" are marked with a number of series of the same kind of tubuli, while in the ordinary interspaces between the zooecia they arrange themselves into two flexuous and often interrupted lines. It is, however, only in exceptionally preserved spots that these tubuli are recognizable, they being generally represented by apparently structureless dark lines.

In good transverse sections dividing the zoarium vertically but at right angles to the direction of growth, these tubuli are very plain between the divisional laminae.

This fine species is clearly distinct from any other species of the genus known to me, while in its generic characters it is as typical of *Pachydictya* as is *P. robusta*, the type of the genus. Its foliaceous zoarium will distinguish it from all the associated species, with the exception of *Stictoporella frondifera*. That species occurs on the same slabs, and a careless collector might confound them. Still, after a little study, the differences in the size and shape of their cells will become so evident that they may be distinguished at a glance.

Formation and locality. Apparently restricted to the lower

layers of the Trenton shale, in which it is abundant, at Minneapolis, Minn.

Register No. 5948.

PACHYDICTYA OCCIDENTALIS, n. sp.

Zoarium ramose, or subpalmate towards the base, dividing above into small branches; width of branches varying from 0.13 to 0.40 of an inch. Cross section of branches acutely elliptical, about 0.05 inch in thickness centrally. Margins sharp with a narrow, smooth or finely striated, non-poriferous border. Cells arranged in longitudinal, and more or less regular intersecting diagonal series; apertures ovate, slightly longer than broad. About six cells in 0.1 inch, measured longitudinally, and eight in the same space measured diagonally. The wider specimens exhibit along the center of the branch a series of smooth and apparently solid spots, which vary considerably in size. All the examples noticed present at least one of these spots, situated just below the bifurcation of the branches.

Internal structure as in other species of the genus.

This species is closely allied to both *P. acuta*, Hall, sp., and *P. fenestelliformis*, Nicholson, sp., and is of interest, principally, because it represents an unequivocal connecting link between those species.

Formation and locality. Not uncommon in the upper layers of the Trenton shales, at St. Paul, Minn.

Register No. 5949.

PACHYDICTYA FIMBRIATA, n. sp.

Zoarium small, ramose, dividing dichotomously at variable intervals. Branches thin, rarely more than 0.02 of an inch in thickness, and from 0.09 to 0.18 of an inch in width. Non-poriferous margin, obliquely striated, very wide, extremely thin and sharp, and wavy or ruffled. Over about one-half the surface along the middle of the branches the cells are arranged in regular alternating or sub-alternating longitudinal series, in which six to seven occupy the space of 0.10 inch; measuring transversely five rows occur in 0.05 inch. The two or three

rows between these and the non-poriferous margin are not so regular in their arrangement, their apertures being, besides, separated by somewhat wider interspaces, and, usually at least, directed obliquely outward. Cell apertures broadly elliptical, longer than wide, and, in perfectly preserved examples, surrounded by a faintly elevated, thin border. Inter-apertural spaces about half as wide as the longer diameter of the cell-mouths, smooth or faintly striated longitudinally.

Internal structure as in *P. acuta*, and other species of the genus.

Good examples of this species cannot be confounded with any other species known to me, as the wavy or ruffled appearance of the wide non-poriferous margin gives them a very peculiar and characteristic aspect. In other respects the species is very closely related to *P. acuta*, Hall, and less closely to *P. occidentalis*, Ulrich.

In the higher layers of the Trenton shales at St. Paul, I have noticed a number of specimens, which, while it does not seem probable, may still prove to belong to a robust variety of this species. In these the non-poriferous margin is wide, but not wavy, and the cell-apertures smaller and narrow, while the walls or interspaces are thick and usually wider than the apertures, and more distinctly striated. The branches have an average width of 0.18 inch, and a thickness of 0.06 inch or more. Should these differences prove constant then they ought to be considered as of specific importance.

Formation and locality: Rather common in the lower part of the Trenton shales, at Minneapolis, Minn.

Register No. 5950.

PACHYDICTYA CONCILIATRIX, n. sp.

Zoarium consisting of triangular stems, celluliferous on the three concave sides, and constructed on the same general plan as *Prismopora*, Hall. Margins sharp, non-poriferous, and faintly striated. Branching takes place by the development of a non-celluliferous ridge in the centre of one of the sides, which, rising gradually, eventually forms one of the non-poriferous margins of the new branch or stem. Cell apertures sub-

circular to oval, arranged in longitudinal series in the central third of the sides, while those nearer the margins are larger and directed obliquely outward and upward. Interstitial spaces of somewhat variable thickness, usually equaling about one-half the diameter of the apertures; surface minutely granular, and where the cells have a regular arrangement, the granules form rows. Measured longitudinally, six or seven cells occupy 0.1 inch. Width of branches varying from 0.13 to 0.18 of an inch.

This very interesting and I might say prophetic species, demonstrates what I have only suspected heretofore. That is, the relationship of *Pachydictya* with the *Cystodictyonidae.* In fact, the genus lacks only the small "lip" to be a typical member of the family, and it is questionable whether this deficiency is of sufficient importance to exclude the genus.

Formation and locality: Trenton group at Cannon Falls, Goodhue county, Minnesota, where it is associated with *Phyllopora? corticosa,* Ulrich, and *Streptelasma corniculum,* Hall.

Register No. 5952.

CREPIPORA IMPOLITA, n. sp.

Zoarium large, solid, irregularly ramose, or simply nodulated. Branches from 0.2 to 0.8 of an inch in diameter. Hight from two to four inches. Cells large, and rather regularly arranged, eleven in the space of 0.2 inch. Walls thin. Apertures direct, polygonal to sub-rhomboidal, with the lower margin very slightly elevated, and showing, in good specimens, the ends of the two vertical lamellae or teeth on the inside of the aperture. Interstitial cells, always few, usually absent. When present they are gathered ogether so as to form small "maculae."

In tangential sections the walls are seen to be thoroughly amalgamated, and the vertical lamellae or "teeth" usually represented by two spots on one side of the tube, that are of a conspicuously lighter color than other portions of the wall. In better sections their normal appearance may be observed. This is crescentic or horse-shoe-shaped, with the ends projecting into the cell-cavity.

In longitudinal sections, the tubes are gently curved, apparently throughout their length, and crossed at remote intervals, by exceedingly thin, straight diaphragms. The walls seem to have been perforated by numerous connecting "foraminae" and are composed of rapidly alternating dark and lighter shades of sclerenchyma.

The transverse section is very nearly like the tangential; proving that the branches are not divided into differentiated "mature" and "immature" regions, but that the zoarium is really of the nature of massive or parasitic species.

This very abundant species is readily distinguished from all the associated forms, by its irregular growth and large cells.

Formation and locality: Trenton shales at Minneapolis, Lanesboro, and other localities in the state.

Register Nos. 5958 to 5962.

MONTICULIPORA GRANDIS, n sp.

Zoarium irregularly massive and often tending to become sub-ramose. Cells polygonal, thin walled. Surface without monticules but exhibiting at intervals of 0.2 of an inch conspicuous groups of large cells, that are often nearly twice the size of those of the ordinary dimensions. Eight or nine of the smaller occupy 0.1 inch; the average diameter of those in the groups is about 1-55th of an inch.

In vertical sections the tubes proceed to the surface in straight or curved lines according to the form of the zoarium. They are provided with thin walls, and usually two, more or less closely arranged series of cystoid diaphragms, one on each side of the tube, the intervening space being crossed by an equal number of straight diaphragms.

Tangential sections show that the cells are polygonal and thin-walled; the opening left by the cystoid diaphragms is large, ovate, or sub-circular, and while it is usually lateral in position, it is not infrequently central. The angles of junction of the cells are a little thickened, and there is some evidence to show that they contained very small spiniform tubuli.

This fine species resembles in its growth the more irregular examples of *M. laevis*, Ulrich, from the Cincinnati group. The

cells of *M. grandis*, are however larger and the internal structure quite different.

Formation and locality: Fragments of this species are rather rare in the lower portion of the Trenton shales, at Minneapolis, Minn. The vertical range of the species is apparently not more than six or eight feet.

Register No. 5969.

HOMOTRYPA MINNESOTENSIS, n. sp.

Zoarium ramose, branches cylindrical or sub-cylindrical, from two to four tenths of an inch in diameter, and branching at rather long intervals, that are rarely less than one and a half inches and often more than two inches. Surface smooth, no monticules having been observed in any of the numerous examples studied. Cells of conspicuously larger size than the average are collected into groups, of which the centers are about 0.13 of an inch apart. The cells composing the groups enlarge gradually, those near the middle being about twice as large as the ordinary cells occupying the intervening spaces. Center of groups often marked by a small sub-solid or pitted space. Ordinary cells polygonal, with thin walls, and, sometimes, very oblique apertures; more commonly they are nearly direct, while in a few of the large specimens they are really so. About eleven of the smaller or ordinary cells occur in the space of 0.1 inch.

Vertical sections show that the peripheral or "mature" region is very narrow, that the tubes are long and vertical in the axial region, and that their course to the aperture forms a very gentle curve. The walls in the axial region are extremely thin and wavy. Near the surface they are appreciably thickened. Diaphragms wanting in the axial region, but present in the peripheral portion of the tubes, where they recur at intervals of from one-fourth to one tube diameter. Along the upper wall is the characteristic series of cystoid diaphragms. The obliquity of the cell-apertures and the extreme brevity of the matured portion of the tubes, render the preparation of satisfactory tangential sections very difficult. The more successful ones show that the cell walls are compar-

atively thin, that a variable number of interstitial cells is interpolated among the ordinary zoœcia, while here and there, somewhat obscure traces of the connecting foraminae may be detected.

Transverse sections show the greatly disproportionate development of the axial region as compared with the peripheral. They also show that in the axial region the tubes are provided with extremely thin walls, and that near the surface they are flattened and their size considerably reduced.

This is a true species of *Homotrypa*, and is nearly related to *H. obliqua*, Ulrich, from the Cincinnati group of Ohio, but still closer in its affinity with an undescribed species occurring in the upper half of that formation. From the first, *H. minnesotensis* is distinguished by its smooth and sub-cylindrical branches, and other less obvious, differences.

Formation and locality: Common in the Trenton shales at Minneapolis, St. Paul, Lanesboro, and other localities in the state.

Register Nos. 5970 to 5975.

HOMOTRYPA EXILIS, n. sp.

Zoarium ramose, branches slender, cylindrical, about 0.15 of an inch in diameter, and dividing at intervals of one inch or more. Entire hight of zoarium from one to three inches. Surface smooth. Cells with rounded, direct apertures, and moderately thick walls. Ten or eleven of the ordinary size occur in the length of 0.1 inch. Groups of cells, slightly larger than the average, are present, but do not constitute a conspicuous feature. Interstitial cells rather numerous, especially between the cells of the groups just mentioned. Diaphragms, wanting in the axial region, but present in the short, abruptly bent peripheral region, where the walls are also thickened, and a short series of cystoid diaphragms is developed.

At first I was inclined to regard this species as the young of *H. minnesotensis.* But this is evidently not the case, as the specimens have a more matured look than many much larger specimens of that species. The walls get thicker and the apertures more rounded than is the case in even the most matured examples of *H. minnesotensis.*

Formation and locality: Not uncommon in the lower portion of the Trenton shales at Minneapolis, Minn.

Register No. 5976.

HOMOTRYPA SUBRAMOSA, n. sp.

Zoarium sub-ramose, branches sub-cylindrical or slightly flattened, with the upper extremities rounded and expanded.—Branches varying in diameter from 0.2 to 0.4 of an inch; apparently dividing but once or twice, the entire zoarium being rarely more than one inch and a half in hight. Surface without monticules. Cells with moderately thin walls, and polygonal and direct apertures; nine or ten occupy the space of 0.1 inch. At irregular intervals the surface presents inconspicuous clusters of cells that are slightly larger than the average. Well developed spiniform tubuli occur at most of the angles of junction between the cells. They constitute a marked feature on all good specimens.

Longitudinal sections show that the tubes proceed from the axial region to the outer surface in a gentle but gradually increasing curve; that at unequal intervals several parallel convex lines of diaphragms cross the branch; that between these the diaphragms may be absent or scattered and infrequent; that the walls throughout the axial region are thin and decidedly wavy; that they are moderately thickened in the peripheral or "mature" region, and are there provided with a more or less closely arranged series of cystoid diaphragms, the extent of which, of course, depends entirely upon the age of the specimen.

In tangential sections the walls are moderately thin, the cell-cavity is sub-angular, and exhibits usually at one side the crescentic opening left by the cystoid diaphragms. The spiniform tubuli are large, and as the walls are comparatively thin, they are more striking than usual with species of the genus.

This is not closely related to either of the preceding species, but finds its nearest allies in several undescribed species of Ohio and Kentucky.

Formation and locality: Not common in the Trenton group at Minneola, Goodhue Co., Minn.

Register No. 5980.

HOMOTRYPA INSIGNIS, n. sp.

Zoarium sub-ramose, from one to two inches in hight; branches sub-cylindrical or flattened, often lobate, or throwing off short branches, the distal extremities of which are concave. Diameter of branches varying from 0.15 to 0.30 of an inch. Surface smooth, without monticules. Cells with very thin walls, and shallow apertures. These two conditions conduce to give the cell-apertures, especially those of the younger specimens, the appearance of being extremely oblique, when in fact they are but slightly so, and in old examples not at all. An explanation of this peculiarity is found in the fact that the cystoid diaphragms occur just beneath the top of the thin cell-walls, and the least wearing will remove the wall all around the cell excepting at the small posterior opening left by the cystoid diaphragms. Groups of cells of larger size than the average, occur at intervals of about 0.12 of an inch. Ten or eleven of the ordinary cells occupy 0.1 inch.

Tangential sections show that the walls are thin, that small spiniform tubuli occupy many of the angles of junction, and that the sub-circular opening or tube left on the posterior side of the cell by the cystoid diaphragms, is comparatively small, and unless sharply defined, may be overlooked.

In vertical sections the tubes in the axial region are not provided with diaphragms excepting in special zones, where they are numerous. In the peripheral region they are crowded, and although greatly resembling ordinary straight diaphragms, they are, nevertheless, of the nature of cystoid diaphragms. Their posterior portion is in most cases abruptly bent inward, but at a point so near the wall of the tube that it may be overlooked.

The distinguishing features of this species are the thin walls, the shallowness of the cells at their apertures, and the large size and number of the cystoid diaphragms. Slightly worn examples are readily identified by the peculiar obliquity of the cell-apertures, which for the reasons given in the description, appear to be very small, the larger portion of the surface being occupied seemingly by wall-substance.

Formation and locality: Rather rare in the Trenton shales near Fountain and Lanesboro, in Fillmore Co., Minn.

Register Nos. 5977 to 5979.

HOMOTRYPELLA, nov. gen.

Zoaria somewhat irregularly ramose, rarely frondescent; monticules wanting; small maculae of interstitial cells usually present. Zoœcia small, with moderately thick walls and cystoid diaphragms. Interstitial cells numerous, often completely isolating the true zoœcia; diaphragms straight. Spiniform tubuli very numerous, of medium size, and frequently encroaching upon the visceral cavity of the zoœcia.

Type: *H. instabilis*, n. sp.

The above characters are represented in at least six species now before me. They are all new to science with the exception of one, a description of which has been published by me under the name of *Chaetetes grameliferus** It is a common species in the Trenton shaly limestones of Kentucky. Of the remaining five species, three occur in the Cincinnati group of Ohio, one in the same formation in Illinois, and the last in the Trenton shales of Minnesota. Judging from the aggregate of characters, the position of the genus is intermediate between *Peronopora,* Nicholson, and *Atactoporella,* Ulrich, on the one side, and *Homotrypa,* Ulrich, on the other. The genus is also related to *Leioclema* and *Batostomella,* Ulrich, but differs in the tabulation of the zoœcia.

HOMOTRYPELLA INSTABILIS, n. sp.

Zoarium ramose, branches rounded, sometimes irregularly nodular or lobate, and varying in size, some being slender and not more than 0.18 of an inch in diameter, while others are much heavier and in several instances exceed 0.3 inch in diameter. Superficial aspect of cells presenting a variety of appearances depending upon the age and preservation of the specimens. In well preserved younger examples the cells are comparatively thin-walled, subcircular, and surrounded by slightly smaller, angular, interstitial cells. When a little worn, and this is especially the case in the larger specimens, the walls appear very thick, the cell-apertures, sub-circular or irregularly inflected, and the interstitial cells scarcely recognizable as such; or the visceral cavities of the latter are filled solid, and the observer is apt to

*Jour. Cin. Soc. Nat. Hist. vol. 2, p. 128.

suppose that they are absent. In well preserved and fully matured examples the interstitial cells are again obscured by the spiniform tubuli. These are rather small but numerous, there being two or three to each cell. Small "maculae" of interstitial cells, usually appearing as non-poriferous smooth spots, may occur at intervals of about 0.12 of an inch. Eleven or twelve of the true zoœcia occupy 0.1 inch; the diameter of their apertures is about $\frac{1}{200}$th of an inch.

In tangential sections the polygonal line of contact between the cells is nearly always sharply defined. The interstitial cells are numerous and of unequal size, though usually of much smaller size than the true zooecia. The walls of both kinds of cells are of equal thickness, the portion of same immediately surrounding the visceral cavity, being also of darker hue than beyond. Visceral cavity of true zoœcia often sub-circular or ovate, but more commonly with an irregular outline, due to the encroachment of the conspicuous spiniform tubuli. These are nearly or quite as large as the interstitial cells, and differ from them only in having their central portion entirely filled by a dark deposit of sclerenchyma. Their number varies from one to three times that of the true zoœcia. At unequal intervals the section presents small irregular aggregations of the interstitial cells. The cystoid diaphragms are not present in these sections excepting when they are prepared from very young examples or cut the zoarium at a deep level.

In the axial region of a vertical section the walls of the tubes are thin and undulated, the diaphragms straight and remote, and the direction of the tubes, from their point of origin to where they enter the "mature" or peripheral region, forms an angle of about twenty degrees with the imaginary central axis of the branch. In the peripheral region this angle is gradually increased until the maximum of about seventy-five degrees is attained. At the same time the walls are much thickened, and the numerous interstitial cells and spiniform tubuli are developed. The former are distinguished from the true zoœcia by the fact that they are intersected by straight, complete diaphragms only, while the true zoœcia have the superior wall lined in a portion of their length by a series of cystoid diaphragms. These structures number from eight to fifteen in each tube, and are developed only in the

region intervening between the fully matured peripheral and the immature axial region. Beyond them the diaphragms are crowded and essentially horizontal. In the interstitial tubes they are scarcely more crowded than in the true zoœcia, and, especially in the outer portion, more or less obscured by sclerenchyma.

It is highly probable that the above description embraces more than one species. Both extremes in size present, besides some important differences in internal structure. These have not been noted in the descriptions of the sections, the character of what I regard as the typical form alone being given. Until I can give more time to the examination of the relative importance of the variations noticed, I have deemed it, in the meantime, advisable to describe them under one specific name.

Formation and locality: Rather common in the Trenton shales, at Minneapolis and other localities in the state of Minnesota.

Register Nos. 5025, 5981 and 5982.

PRASOPORA SIMULATRIX, n. sp.

Zoarium discoid when young, hemispheric or depressed subconical when adult; base more or less concave, and covered with a concentrically striated epitheca; upper surface celluliferous; hight of zoarium varying from one-fourth of an inch to two inches; diameter from one-half of an inch to four inches. Zoœcia or true cells with sub-circular apertures, and comparatively thin interspaces that are occupied by rather numerous small angular interstitial cells. Groups of cells of a slightly larger size than usual occur at intervals of 0.15 inch, measuring from center to center. Between these the interstitial cells are always more numerous than elsewhere, and not infrequently form a small "macula" in the central portion of the clusters. In the spaces between the "maculæ" the interstitial cells might be overlooked, although as shown by sections, they are really numerous. Diameter of apertures of one of the ordinary cells about 1-105th of an inch, while nine of the same occupy 0.1 inch.

In tangential sections the true zoœcia are sub-circular, or more strictly speaking, polygonal, the walls very thin, and the

visceral chamber invariably intersected by the crescentic edge of the cystoid diaphragm. The opening left by the cystoid diaphragms is either lateral or sub-central, but more commonly the former. The zoœcia are in contact only at limited points, and the interspaces between them are filled by the small interstitial cells. These are somewhat variable in number, and greatly so in size, but always decidedly angular. They are furthermore, collected at intervals into small sub-stellate groups or "maculæ."

Vertical sections show that the cystoid diaphragms form a continuous series on one or both sides of the tubes, according as they extend all around the circumference, or take in only a portion of the same, while an equal number of straight diaphragms crosses the remaining portion of the tube. The interstitial tubes are crossed by about twice as many simple horizontal diaphragms. The cell-walls throughout are very thin.

This species in many respects closely resembles *P. Selwyni*, Nicholson, but they differ so decidedly in the internal structure that I must regard them as distinct. In the true, or what Dr. Nicholson calls the typical form of *P. Selwyni*, the cystoid diaphragms are isolated, and never form connected series as they do in *P. simulatrix*, *P. grayæ*, Nich., and Eth. jr., and a number of other species. A similar and even more marked isolation of the cystoid diaphragms pertains to *P. oculata* and *P. affinis*, described by Foord from the Trenton of Canada. None of the Canadian species of the genus, so far as known, occur in the Trenton rocks of Kentucky and Tennessee, nor in the equivalent strata of the northwest, and it is singular that all the American species have the cystoid diaphragms in more or less crowded continuous rows, while in the Canadian species the isolated condition of these structures prevails. Nicholson's variety *hospitalis*, of *P. selwyni*, is more nearly related to *P. simulatrix*, but differs in having spiniform tubuli, and an attached zoarium. But why *P. hospitalis* should be called a variety, is more than I can understand. The parasitic habit of growth, spiniform tubuli, and mode of tabulation distinguish it, at least specifically, from *P. selwyni*.

Formation and locality: In the Trenton shales, but apparently not common in any locality in the state. It has been found at Minneapolis, St. Paul, Lanesboro and Mantorville. In the shaly

limestones of the Trenton in Kentucky and Tennessee the species is exceedingly common, and grows to a larger size than the Minnesota specimens.

Register Nos. 4041, 5124, 5532, 5986 to 5988.

PRASOPORA CONOIDEA, n. sp.

Zoarium depressed, conical; base rather deeply concave, and covered with a concentrically wrinkled epitheca; hight varying from 0.2 to 0.6 of an inch; diameter from 0.4 to 0.8 of an inch. Upper surface celluliferous and exhibiting, at intervals of 0.12 inch, more or less prominent monticules, mainly occupied by groups of cells larger than the average. The summits usually appear to be sub-solid, but sections show that this portion of the monticules is occupied by an aggregation of small interstitial cells. Zoœcia with sub-circular or polygonal apertures; ten of the ordinary size occur in the length of 0.1 inch.

Both the vertical and tangential sections resemble those of *P. simulatrix* to a marked degree. In fact they are identical in all respects. excepting that the tangential section of *P. conoidea* shows a few spiniform tubuli, and usually fewer interstitial cells, though the maculæ between the groups of large cells are generally of greater dimensions than we find them in such sections of *P. simulatrix*. As the differences in internal structure are so slight, the external characters, such as the form of zoarium and monticules, must mainly be relied upon in distinguishing the two species. In nearly one hundred specimens of *P. conoidea* examined, the small size, sub-conical form, more or less developed monticules, and concave base, are very persistent characters, and sufficient to distinguish specimens of the two species at a glance.

Formation and locality: At Oxford mills near Cannon Falls, Goodhue county, associated with *Phyllopora? corticosa*, Ulrich, *Streptelasma corniculum*, Hall, and *Pachydictya conciliatrix*, Ulrich.

Register No. 3483.

PRASOPORA CONTIGUA, n. sp.

Zoarium hemispheric, base flat or slightly concave, usually one-

half or three-fourths of an inch in diameter, and rarely one inch or more; a single specimen, apparently belonging to this species, is, however, about four inches in diameter. Zoœcia with thin walls and polygonal apertures; nine of the ordinary size occupy 0.1 inch. Groups of cells of somewhat larger size than usual occur at intervals of 0.15 inch. Their diameter rarely exceeds $\frac{1}{70}$ of an inch. Interstitial cells scarcely detectable at the surface.

Tangential sections show that the zoœcia are polygonal, and thin-walled; that they are in contact excepting at their angles, where one or two small interstitial cells are wedged between them; that in the centre of the groups of large cells there is usually a small aggregation of the interstitial cells; and that a few spiniform tubuli are developed. The tubular opening left by the cystoid diaphragms is of medium size, and more often excentric than central in its position within the tube cavity.

Vertical sections are remarkable mainly, because they exhibit a marked decrease in the number of interstitial cells, when compared with other species of the genus.

The superficial aspect of the celluliferous surface of this species is very much like that of species of *Monotrypa*, and to a less degree, also resembles that of *Prasopora simulatrix*. Still, after a little practice they are readily distinguished by the thinner cell-walls of *P. contigua*. Tangential sections will immediately prove their distinctness. The same species, very slightly modified, occurs in the Cincinnati group at Cincinnati, Ohio, about three hundred feet above the Ohio river.

Formation and locality: In the Trenton shales at localities in Goodhue and Dakota counties.

Register Nos. 5301, 5989, 5534.

DIPLOTRYPA INFIDA, n. sp.

Zoarium discoid, sometimes approaching hemispherical. Base flat or slightly concave; hight from one to three tenths of an inch; diameter from one-half an inch to one inch. Zoœcia varying in form from polygonal to sub-circular, the shape depending upon the number and size of the interstitial cells. In some specimens these cells are almost certain to be overlooked, as the

zoœcia are angular and seemingly in perfect contiguity. In others the interstitial cells are large and very obvious between the true zoœcial apertures, which in these specimens are circular. At intervals of 0.15 inch, measuring from center to center, there are conspicuous clusters of zoœcia of larger size than usual, the diameter of the apertures of the ordinary cells being only about 1–110th of an inch, while that of those forming the clusters varies from that size to 1–65th inch. Nine or ten of the ordinary zoœcia occupy the space of 0.1 inch.

Tangential sections vary somewhat in the appearance they present, according to the depth below the surface at which they divide the zoarium. When taken just below the surface of a specimen with angular zoœcial apertures the interstitial cells, although numerous, are small and wedged in between the zoœcia, the walls of the latter being largely in contact with each other. Spiniform tubuli of moderate size are developed at most the points of junction between the zoœcia. At a deeper level the zoœcia are sub-circular, and from their shape alone are necessarily in contact with each other only at limited points. The interstitial cells are, moreover, much larger, and somewhat more numerous than they are in the region just described.

In vertical sections the tubes are everywhere perpendicular to the basal epithecal membrane. Their walls are not excessively thin, being slightly thicker than is usual with species of the genus. The interstitial tubes are more conspicuous in the lower half of the section than in the upper where the true zoœcia are often in contact. That condition is less frequent in the lower region. The diaphragms in the zoœcia are numerous but extremely variable, some being horizontal, some more or less oblique, while others are curved and overlapping, and occasionally present the appearance of short irregular series of cystoid diaphragms. The diaphragms in the interstitial tubes are crowded and horizontal. The thick-walled spiniform tubuli are rather conspicuous in these sections.

It is difficult to determine whether this species has more affinity with *Prasopora* or *Diplotrypa*. The only important character distinguishing the two genera is found in the cystoid diaphragms. These structures are not present in the typical species of *Diplotrypa*, but in *D. regularis*, Foord, the diaphragms are usually

oblique and often curved, while *D. infida* goes but a step farther in having some of them overlap like cystoid diaphragms. In tangential sections, however, the appearances presented are more like those of *Diplotrypa* than *Prasopora*, the interstitial cells being somewhat larger than is usual in the latter genus, and the very striking appearance of the cystoid diaphragms of *Prasopora*, when cut transversely, is either absent or occurs only here and there in isolated instances. So, while the species is undoubtedly intermediate between the two genera, the greater affinity seems still to be with *Diplotrypa*.

Formation and locality: In the Trenton shales of Goodhue and Fillmore counties.

Register No. 5993.

ASPIDOPORA PARASITICA, n. sp.

Zoarium adhering to foreign bodies, upon which it forms thin sub-circular patches usually about one-half an inch in diameter, and from one to three hundredths of an inch in thickness. In a few instances noticed, the shell upon which the zoarium had commenced its growth proved too small, and the under side of the colony, where it projects beyond the encrusted body, is covered by a faintly wrinkled epitheca. Zoœcia with oval or circular apertures, moderately thin walls, and a regular arrangement in curved series around groups of cells larger than usual; about ten of the cells in the spaces between the "clusters" occur in 0.1 inch. Interstitial cells numerous, but, as a rule, they are obscure at the surface and readily overlooked. Spiniform tubuli rather numerous and recognizable at the surface of all well preserved examples.

Vertical sections show the extreme tenuity of the zoarium. The zoœcia are at first somewhat prostrate, but they soon bend upward and open at the surface with direct apertures. One large cystoid diaphragm is, apparently always present at the bottom of the cell, and I do not doubt that with age, a short series of them is developed. The interstitial tubes expand very rapidly above their point of origin, which is just above the basal or epithecal membrane. They are crossed by from five to ten close-set horizontal diaphragms.

In tangential sections the zoœcia are sub-circular or oval, and in contact with each other at two, three, or four points, the sub-rhomboidal or irregular spaces intervening being occupied by the interstitial cells. Walls of zoœcia thin. Spiniform tubuli of moderate size occur at nearly all the points of contact between the zoœcia.

The parasitic habit of the species distinguishes it from all other species of the genus known to me. Otherwise it is closely allied to both *A. newberryi*, (*Prasopora newberryi, Nicholson*) and *A. calycula* (*Diplotrypa calycula, Nicholson*), from the Cincinnati group of Ohio. I know of no associated species sufficiently resembling it to require a close comparison.

Formation and locality: Not uncommon in the Trenton shales at Minneapolis, St. Paul and other localities in the state of Minnesota

Register Nos. 5994, 5995.

AMPLEXOPORA WINCHELLI, n. sp.

Zoarium irregularly ramose; branches cylindrical, but oftener more or less flattened, and varying in diameter from 0.2 to 0.35 of an inch. Entire hight of zoarium, apparently, not more than two inches. Monticules are absent, though, now and then, the surface is very slightly undulating. The cells are small, thick-walled, of nearly equal size, rather irregular in their arrangement, and when well preserved the walls show at the angles of junction the elevated points of the spiniform tubuli. Interstitial cells sparingly developed, or wanting. On an average nine cells occupy 0.1 inch.

In longitudinal sections the tubes in the "immature" or axial region are thin-walled, and crossed by complete diaphragms from one to three tube diameters distant from each other. In the peripheral or "mature" region they bend outward rather abruptly, and proceed directly to the surface. As they enter this region their walls become much thickened; in some sections this thickening of the walls is extreme. As usual, the diaphragms are also more numerous, often crowded, and not infrequently exhibit a tendency to coalesce with each other.

Tangential sections exhibit considerable variation in the thick-

ness of the cell walls. This variability is due, apparently, to the different ages of the specimens sectioned. In the younger examples the thickness of the walls equals about one third of the diameter of the cell-cavity, while in very old specimens the cavity may be reduced by additional deposits of sclerenchyma to a diameter equaling scarcely more than one-third the thickness of the walls. The boundary line between adjoining cells is distinctly defined by a dark line. Each of the angles, and often points between them, are occupied by a spiniform tubulus of medium size. When in a good state of preservation the central lucid spot of the spiniform tubuli is seen to be larger than usual with species of this genus.

In some respects this species is related to the *A. canadensis*, described by Foord from the Black River and Trenton formations of Canada. But the branches of that species are much larger, while the thickness of the cell walls does not approach that observed in matured examples of *A. winchelli*. They also differ in the tabulation and direction of the tubes, as well as in the size and number of the spiniform tubuli. Associated with this is a common species having all the characters, save one, ascribed to *A. superba*, Foord. In the Trenton rocks of Canada the surface of that species presents small monticules. These are wanting in the Minnesota specimens, but as the presence or absence of monticules, especially in the genus *Amplexopora*, is of small importance, I think I am justified in regarding them as specifically identical with the Canadian specimens. The larger cells and more robust zoarium of *A. superba*, readily distinguish that species from *A. winchelli*.

The specific name is given in honor of Prof. N. H. Winchell, the accomplished chief of the survey.

Formation and locality: Common in the Trenton shales at Minneapolis, Minn.

Register Nos. 5999 *to* 6001.

BATOSTOMA FERTILIS, n. sp.

Zoarium large, varying from ramose to sub-frondescent, or palmate; branches usually more or less compressed, and varying in thickness from 0.2 to 0.4 inch; width of same, from 0.3 inch

to 1.2 inches; hight, so far as observed, not exceeding 2.5 inches. Cell-apertures varying from polygonal to circular, according to the thickness of the walls, and the size and number of the interstitial cells. In some specimens having sub-circular cells and the apertures surrounded by a slight rim, the interstitial cells are very numerous in the depressed inter-zoœcial spaces. This condition is, however, not common, yet in no instance have I found it difficult to recognize the interstitial cells, as they are more or less numerous in all the specimens. Spiniform tubuli numerous but very small, and only rarely presenting their superficial terminations. At intervals of about 0.12 inch, the surface usually presents small sub-stellate maculae, around which the zoœcia are generally somewhat larger than usual. Seven or eight cells of the ordinary size occupy 0.1 inch.

In vertical sections the tubes have thin, and somewhat irregularly fluctuating walls in the axial region of the zoarium. They proceed toward the surface in a gentle curve, and as they near the same, their walls become appreciably thickened, but never to any great extent. The interstitial tubes are abruptly developed, and constricted at the points where they are crossed by the diaphragms. These occur at but slightly shorter intervals than those in the peripheral regions of the true zoœcia, where they are separated by distances equaling from one-third to one tube diameter. In the axial region the diaphragms are either very remote, or more commonly, are entirely absent.

Several tangential sections show that the zoœcia are always more or less angular; that they have thin walls, and often are in contact with each other on all sides, but usually more or less separated by angular interstitial cells; that the interstitial cells are especially developed, both in size and number, at rhythmical intervals corresponding to the small "maculae" observed at the surface; and that the spiniform tubuli, though numerous, are small and only faintly defined, so that, unless searched for, they may be overlooked.

This species is not closely related to either of the other species of the genus now known from the Trenton formation of Minnesota. Both *B. ottawaensis*, Foord, and *B. irrasa*, Ulrich, have, when matured, very thick-walled cells, while those of *B. fertilis*, are, except in rare instances, comparatively thin-walled. Their

internal characters are too distinct to require comparison. A more closely allied species occurs in the upper beds of the Cincinnati group of Ohio, and another in the Utica slate of Canada, and the equivalent formation in Kentucky. As no descriptions of these species have yet been made public, it would be useless to institute comparisons.

Formation and locality: Abundant in the lower half of the Trenton shales at Minneapolis and other localities.

BATOSTOMA IRRASA, n. sp.

Zoarium, consisting of small, sub-cylindrical or compressed, and frequently divided branches, usually less, rarely a little more, than 0.3 inch in their greatest diameter. Cells with polygonal apertures and thin walls when young, and with smaller, oval or sub-circular apertures, and thick walls in the fully matured examples; seven or eight occur in the length of 0.1 inch. The spaces between the cell-apertures appear solid in the mature specimens, but in some of the younger examples, with also angular zoœcial apertures, a variable number of irregularly shaped interstitial cells may be recognized. Spiniform tubuli numerous, two or more to each cell; they are large and constitute a conspicuous external feature of mature examples. In such specimens, certain small sub-stellate, smooth spots are most distinct.

Vertical sections show that the tubes have thin and irregular fluctuating walls in the axial region, but less thin than usual; that in this region they are crossed by remote complete diaphragms; that near the surface the diaphragms are nearly straight, but often incomplete and less than a tube diameter apart; that their course from the point of origin to their apertures forms a nearly equally curved line; that their walls become but slightly thickened until just below the surface, where the apertures are contracted by a deposit of sclerenchyma, and many of the walls separate to make room for some very short interstitial tubes or cells, the latter are usually filled by a secondary deposit.

The matured region being very shallow, it is difficult to prepare

satisfactory tangential sections. A very good one shows that the cells just below the surface have thick ring-like walls, that their form is oval or sub-circular, and that they may be in contact or separated by very irregular and unequal interstitial cells, which have been more or less completely filled by an homogeneous deposit of light-colored sclerenchyma. The spiniform tubuli are numerous, and, as is usual in this genus, have the central cavity large and distinct. Where the section cuts the zoarium at a deeper level we observe that the cells were angular and mainly in contact with each other, the interstitial cells being as yet small; while the spiniform tubuli are hardly perceptible.

This very neat species is quite distinct from any heretofore described. In having a few incomplete diaphragms it resembles *B. ottawaensis*, Foord, but otherwise they are quite different. In size of zoarium it approaches *B. implicata*, Nicholson, but the cell walls are not inflected by the spiniform tubuli as in that species, nor do they resemble each other in their vertical sections.

Formation and locality: In the lower portion of the Trenton shales at Minneapolis, Minn. In the excavation for the St. Paul and Northern Pacific bridge pier on the eastern bluff of the river, these layers were exposed and many interesting bryozoa were obtained from them. Of these *Pachydictya foliata*, *Stictoporella angularis*, and *S. frondifera* occur on the same slabs of shale with *Batostoma irrasa*.

CALLOPORA UNDULATA, n. sp.

Zoarium ramose, branches small, slender, about 0.12 of an inch in diameter, and dividing dichotomously at intervals of about 0.4 inch or more. Surface with rounded monticules, that usually coalesce laterally and form, more or less complete, transverse ridges, five in 0.4 of an inch. In some specimens the monticules are separate, while in a few they are almost obsolete. Zoœcia with moderately thin walls, and sub-angular apertures. Interstitial cells comparatively few, very small, readily overlooked. Zoœcial apertures nearly equal in size over all portions of the surface; nine occur in the space of 0.1 inch.

In tangential sections the zoœcia are oval or sub-angular, the

walls of moderate thickness, and preserving the original line of junction between adjoining cells. Interstitial cells though small, are yet larger and more numerous than one is led to believe from an examination of the exterior. Nearly all the angles of junction between the true zoœcia are occupied by them.

Vertical sections present no marked differences from other species of the genus. In fact the species of *Callopora* are remarkably persistent in their internal structure, and the points mainly to be relied upon in distinguishing the species are external. As usual the tubes are closely tabulated for a short distance above their point of origin in the axial region of the zoarium. Subsequently the diaphragms are remote, and it is only just below their apertures that they are again numerously developed. The interstitial tubes are short and closely tabulated. The tube walls are some what thinner throughout the zoarium than is usual.

Transverse sections present the characteristic features of the genus. In the axial region the zoœcia are of two sizes, the larger being sub-circular or polygonal, and, from their shape, in contact with each other only at limited points. The intervening spaces are occupied by more angular cells in every stage of development so far as size is concerned. At the periphery the tubes are cut longitudinally. Here the walls are of moderate thickness, and divided in the center by a dark line. But few interstitial cells are to be seen in this style of section.

The rounded, transverse ridges or annulations will distinguish this species from any other form of the genus described. When these are, as is sometimes the case, but faintly developed, care must be taken in distinguishing it from a small undescribed species of *Monotrypella*, occuring in the same beds.

Formation and locality: Not uncommon in the Trenton shales at Minneapolis Minn.

CALLOPORA INCONTROVERSA, n. sp.

Zoarium ramose; branches smooth, sub-cylindrical, from 0.18 to 0.30 of an inch in diameter, and dichotomously divided at intervals of about 0.5 inch. Zoœcia with oval or sub-circular, rarely polygonal apertures, and rather thin walls. Small groups of slightly larger size than the average are occasionally present.

These are never conspicuous and occur at irregular intervals. Eight or nine of the usual size occupy 0.1 inch. Some of the apertures preserve the opercula. The central perforation is larger than usual and surrounded by a distinct rim. Interstitial cells generally numerous, but varying somewhat in distribution and number in different specimens.

Tangential sections show that the zoœcia are nearly circular or broadly elliptical, that their walls are of moderate, but somewhat variable thickness, and that, usually, they are in contact with each other at as many points as their rounded form will admit. The interspaces are occupied by the interstitial cells. At unequal intervals a few of the latter form small irregular groups. The true zoœcia in the immediate vicinity of these groups are also of somewhat larger size than the average.

In vertical sections the tubes form a gradual but rather short curve to the surface. The tabulation and appearance of the proximal ends of the true zoœcia, are so much like that of the interstitial tubes that it is reasonable to believe that their functions were also alike. From the point of origin till it has attained nearly its mature size, the tube is crossed by twelve or more closely and regularly arranged diaphragms; when suddenly they cease. Near the surface they again become numerous but irregular, while in the intervening portion they occur only at remote intervals, or are entirely absent.

When in a good state of preservation, even small fragments of this species are readily recognized by the characters above described. In the worn condition they may be confounded with an associated species of *Homotrypa*. Sections will, of course, immediately distinguish them.

Formation and locality: Rather rare in the Trenton shales at Minneapolis, Minn.

TREMATOPORA PRIMIGENIA, n. sp.

Zoarium ramose; branches sub-cylindrical or compressed, from 0 06 to 0.12 of an inch in diameter, and dichotomously divided at intervals of 0.2 inch or more; the attached basal expansion is comparatively large, and usually supports several branches;

entire hight of branches apparently not exceeding one inch. Superficial aspect of zoœcia varying with age. In the younger examples the apertures are oblique, with only the posterior border elevated, and the interstitial spaces of less width than the diameter of the apertures. With age the apertures become somewhat smaller, sub-circular, and more direct, and the peristome or rim nearly equally elevated all around, while the interstitial spaces are widened, till in some examples they are equal to twice the diameter of the zoœcial orifice. Most specimens present irregular spots or maculæ, where the zoœcia are of larger size than usual and separated by wide interspaces. In some the maculæ form circumscribed, seemingly solid, spots, thus furnishing a conspicuous feature to the surface; while, on the other hand, in a few, otherwise typical examples, only traces of them can be detected. On the whole, therefore, the arrangement of the zoœcia is irregular. Diameter of apertures varying from $\frac{1}{250}$th to $\frac{1}{175}$th of an inch. From ten to fourteen occupy the length of 0.1 inch, but twelve is the prevailing number. As usual with species of the genus, the orifices of the interstitial cells are closed by a membrane. Sections prove them to be numerous, and that they more or less completely isolate the zoœcia. Spiniform tubuli very small and generally worn away.

Sections present the usual characters of the genus as restricted by me.* In the final report on the palæontology of the state, they will be fully described and illustrated. In this communication it will suffice to state that all the essential characters of *Trematopora* are represented.

The large basal expansion, small branches, rounded cell apertures, and the somewhat depressed, wide, and smooth interstitial spaces, and "maculæ," are the distinguishing features of the species.

Formation and locality: Common at Minneapolis and other localities of the state, in the Trenton shales.

Register Nos. 6010, 6011.

TREMATOPORA ORNATA, n. sp.

The zoarium of this species, in its growth and general appear-

* Jour. Cin. Soc. Nat. Hist., vol. vi, p. 257.

ances, so closely resembles that of *T. primigenia,* that a detailed description will scarcely be deemed necessary. They differ as follows: The zoœcia of *T. ornata* are more closely, as well as more regularly arranged, the interstitial spaces narrower and more depressed, and the "maculæ" absent. When in a good state of preservation, the elevated border around the apertures is surrounded by a closely arranged series of granules or blunt spines, which impart a very ornamental appearance to the magnified surface. A variable number of somewhat larger spines also occurs in the interstitial spaces. The greater development of the spines is the most obvious and important difference, and when preserved, should distinguish the two species immediately.

I am not entirely satisfied that the generic affinities of the species have been correctly determined. Future investigations may prove it to belong to *Bythopora,* Miller.

Formation and locality: Rather rare. Associated with the much more abundant *primigenia,* at Minneapolis, Minn.

BYTHOPORA HERRICKI, n. sp.

Zoarium ramose, less than two inches in hight; branches slender, cylindrical, from 0.03 to 0.10 of an inch in diameter, and divided dichotomously at intervals varying from 0.3 to 0.5 of an inch. Zoœcia arranged in somewhat irregular longitudinal series, with thick walls, narrow and very oblique apertures, the upper end of same being drawn out and shallow. Interspaces or walls sometimes channeled, or with elongate shallow pits. Measured longitudinally about seven cell-apertures occur in 0.1 inch; transversely eight rows occupy 0.05 inch. Spiniform tubuli small, few, and but rarely preserved.

The internal structure of the species has not been determined satisfactorily, being obscured, or entirely destroyed by crystallization. Still the superficial characters of the cells are so much like those of *B. fruticosa,* Miller, the type of the genus, that I feel no hesitancy in referring the Minnesota specimens to the same genus. When in a good state of preservation, *B. herricki* can not be confounded with any of the associated species, the extremely narrow cell-apertures being quite distinctive. The

branches are, besides, more slender and cylindrical than those of *Trematopora primigenia* and *T. ornata.*

Formation and locality: Fragments of this species are quite common in the Trenton shales of St. Paul and Minneapolis, Minn.

Register Nos. 6012, 6013.

MONOTRYPELLA MULTITABULATA, n. sp.

Zoarium consisting of irregularly divided, cylindrical or slightly compressed branches, varying in diameter from 0.15 to 0.4 of an inch. Surface usually presenting more or less elevated monticules, at intervals of 0.1 inch, measuring from center to center. In the Minnesota specimens the monticules are often absent, and instead, we find groups of cells of larger size than ordinary. Zoœcia polygonal, eight or nine in the space of 0.1 inch; walls rather thin. Interstitial cells not to be detected at the surface. Spiniform tubuli wanting.

In tangential sections the zoœcia are seen to be regularly polygonal, in contact at all points of their circumference, and provided with only moderately thickened walls. Further, each is separated from the other by a distinct boundary line, which is often conspicuously thickened where three or more cells come in contact, so as to resemble spiniform tubuli. Here and there occurs a small cell whose nature is doubtful. They are most probably abortive or young, though they may prove to be interstitial.

Vertical sections show that the tubes are provided with an excessive number of diaphragms. In the axial region these structures recur at intervals varying from one to three tube-diameters, while in the peripheral portions of the tubes they are extremely crowded. Many of the diaphragms in this region are slightly curved, and they often join with one another. The duplex character of the walls is preserved throughout the "mature" region, where they are also appreciably thicker than in the axial region. In a few instances the section passes through some small tubes, which present the usual appearance of interstitial tubes.

The distinguishing feature of the species is found in the extremely numerous diaphragms. The thin polygonal cells, and absence of spiniform tubuli, will separate it from the associated ramose bryozoa.

Formation and locality: This is a common species in the Trenton formation of Kentucky. It also occurs rather abundantly in the shales at Minneapolis, Lanesboro, and other localities in the state.

DISTRIBUTION OF SPECIES.

	Cincinnati group.	Trenton shales.	Limestone, Chazy, Black River and Birdseye.	Register No.
1. Stomatopora inflata, Hall		*		5924
2. Berenicea minnesotensis, Ulrich		*		5925
3. Ropalonaria pertenuis, Ulrich		*		5926
4. Arthroclema pulchellum? Billings		*		5927
5. Helopora divaricata, Ulrich		*		5928
6. Helopora spiniformis, Ulrich		*	*?	
7. Helopora, sp. undesc.		*		
8. Phyllopora? sp. undet.			*	5954
9. Phyllopora? recticulata, Hall		*		5955
10. Phyllopora? corticosa, Ulrich		*		3495
11. Ptilodictya subrecta, Ulrich		*		5929
12. Ptilodictya nodosa, Hall		*		5931
13. Ptilodictya ramosa, Ulrich		*		5930
14. Arthropora shafferi, Meek		*		5932
15. Arthropora simplex, Ulrich		*		5933
16. Stictopora fenestrata? Hall			*	5934
17. Stictopora paupera, Ulrich		*		5935
18. Stictopora fidelis, Ulrich		*		5936
19. Stictopora nicholsoni, Ulrich		*	*?	
20. Stictopora mutabilis, Ulrich		*		5938, 5939, 5956
21. S. mutabilis, var. minor		*		5941
22. S. mutabilis var. major		*		5940
23. Stictopora, sp. undesc.		*		
24. Stictopora, sp. undet.		*		
25. Phaenopora multipora, Hall		*		5942
26. Stictoporella angularis, Ulrich		*		5943
27. Stictoporella cribrosa, Ulrich		*		5944
28 Stictoporella frondifera, Ulrich		*		5945–5947
29. Pachydictya foliata, Ulrich		*		5948
30. Pachydictya acuta? Hall		*		
31. Pachydictya occidentalis, Ulrich		*		5949
32. Pachydictya fimbriata, Ulrich		*		5950
33. Pachydictya conciliatrix, Ulrich		*		5952
34. Pachydictya, sp. undet.		*		
35 Phyllodictya frondosa, Ulrich		*		5953
36. Ceramoporella, sp undesc.		*		
37. Ceramoporella? sp undet.		*		
38. Crepipora impolita, Ulrich		*		5958–5962
39. Cheiloporella, sp. undesc.		*		5963, 5964
40. Spatiopora? areolata, Foord		*		5965, 5966
41. Crepipora? sp undet	*			
42. Monticulipora wetherbyi, Ulrich			*	5967
43. Monticulipora, sp. undesc.			*	5968
44. Monticulipora grandis, Ulrich		*		5969
45. Homotrypa minnesotensis, Ulrich		*		5970–5975
46. Homotrypa exilis, Ulrich		*		5976
47. Homotrypa insignis, Ulrich		*		5977–5979
48. Homotrypa subramosa, Ulrich		*		5980
49. Homotrypa. sp undet.		*		
50 Homotrypa? sp. undet		*		
51. Homotrypa, sp. undesc.	*			
52. Homotrypella instabilis, Ulrich		*		5025, 5981, 5982
53. Atactoporella, sp. undesc		*		5983, 5984
54. Atactoporella, sp undesc.		*		5985
55. Prasopora simulatrix, Ulrich		*		4[illegible]41, 5124, 5532, 5986, 5987, 5988
56. Prasopora conoidea, Ulrich		*		3483
57. Prasopora contigua, Ulrich		*		5301, 5534, 5989
58. Prasopora, sp undesc		*		310, 5990–5992
59. Diplotrypa infida, Ulrich		*		5993
60. Aspidopora parasitica, Ulrich		*		5994, 5995
61. Amplexopora superba, Foord		*		5996–5998
62. Amplexopora winchelli, Ulrich		*		5999–6001
63. Amplexopora, sp. undesc		*		

DISTRIBUTION OF SPECIES—*Concluded.*

	Cincinnati group.	Trenton shales.	Limestone, Chazy, Black River and Birdseye.	Register No.
64. Amplexopora, sp. undet		*		
65. Batostoma ottawaensis, Foord		*		6002
66. Batostoma irrasa, Ulrich		*		
67. Batostoma fertilis, Ulrich		*		
68. Batostoma, sp. undesc		*		
69. Batostoma? sp undet		*		
70. Batostoma sp. undet	*			
71. Batostomella gracilis, Nicholson	*			
72. Batostomella sp. undesc		*		5541, 6009
73. Trematopora primigenia, Ulrich		*		6010, 6011
74. Trematopora ornata, Ulrich		*		
75. Bythopora herricki Ulrich		*		6012, 6013
76. Bythopora, sp undesc		*		
77. Bythopora? sp. undesc		*		
78. Callopora, sp undesc		*		6014
79. Callopora, sp undesc		*		6015
80. Callopora incontroversa, Ulrich		*		Not entered.
81. Callopora undulata, Ulrich		*		"
82. Idiotrypa, sp. undesc		*		"
83. Dekayia trentonensis, Ulrich		*		"
84. Dekayia, sp. undesc		*		"
85. Dekayella ulrichi,? Nicholson		*		"
86. Dekayella, sp. undesc		*		"
87. Petigopora petechialis, Nicholson		*		"
88. Petigopora, sp. undet		*		"
89. Leptotrypa, sp undesc		*		"
90. Monotrypella multitabulata, Ulrich		*		"
91. Monotrypella, sp undet			*	
92. Monotrypa, sp. undesc		*		

REMARKS UPON THE NAMES CHEIROCRINUS AND CALCEOCRINUS, WITH DESCRIPTIONS OF THREE NEW GENERIC TERMS AND ONE NEW SPECIES.

BY E. O. ULRICH.

In 1860, in the thirteenth report of the regents of the N. Y. State University, Prof. James Hall proposed the generic name *Cheirocrinus* for a very anomalous group of palæozoic crinoids. Unfortunately this name had already been proposed in 1856, for a genus of cystideans by Eichwald*, and in 1859 Salter† applied the same name to a species apparently congeneric with the species defined by Hall. The subject is complicated still further by the fact that in 1852 Hall‡ applied the name *Calceocrinus* to some triangular crinoidal plates, now supposed to be the basal piece of a crinoid belonging to the same group as those subsequently referred by the same author to *Cheirocrinus*. So far as I have been able to ascertain, this supposition has not yet been verified, and rests solely upon the resemblance first suggested by Shumard. Admitting the resemblance, I would still protest against the use of *Calceocrinus* instead of *Cheirocrinus*, for the following reasons: (1) According to modern rules of nomenclature, *Calceocrinus* cannot be regarded as an established genus, since it was not founded upon a named nor described species. (2) The triangular plates so designated may belong to any one of at least three distinct generic groups, and as these basal pieces are so nearly alike in all, it is quite impossible to determine from

*Bullet, Soc. Nat. Moscou, p. 69.
†Siluria, 2d edit., p. 535.
‡Pal. N. Y., vol. II, p. 352.

the description and figure, for which of the groups the name would be entitled to stand, in case the first objection is ruled out.

After a careful examination and comparison of the various species of this peculiar family of crinoids now known, I have come to the conclusion that they fall naturally into three distinct and easily distinguished groups. These are separated by such well-marked and constant characters that I feel justified in regarding them as of generic importance. Had I found it possible to determine to which, if any, of these three genera the original specimens of *Calceocrinus* belong, I would have been willing to overlook the objections raised against the use of that name. Being, however, unable to do so, I am obliged to ignore it, when dealing with species whose characters are sufficiently known to make their generic affinities clear, while I would suggest that the name be used temporarily for the reception of such species as are too little known to admit of unquestioned classification, and yet are unequivocal members of the family.

The classification proposed is briefly defined as follows:

CREMACRINIDÆ, n. fam.

Natural position of body and arms drooping. Basal plate subtriangular, composed of several anchylosed pieces, and articulating with the body plates in such a manner as to allow of more or less movement. Columns attached to the lower angle of the basal piece. Plates of body unsymmetrical, consisting on the dorsal side of two large dorso-lateral pieces, and two often much smaller central plates; on the ventral side of three generally completely anchylosed pieces which form an arch adapted to the shape of the movable basal piece. Arms unequal, but developed symmetrically on each side of a centro-dorsal arm, usually much the strongest. Ventral tube long; its supporting plates rest upon the ventral arch.

(Figs. 1, 2 and 3.)

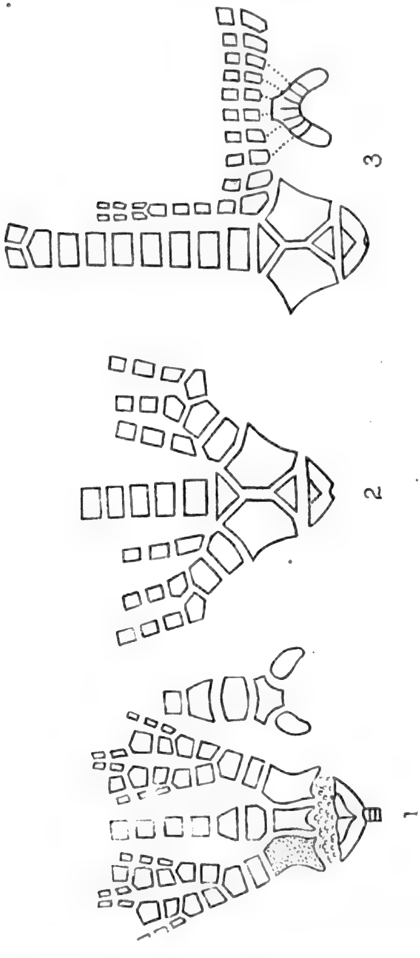

Fig 1. Diagram showing structure of body and arms of *Cremacrinus punctatus*, n. gen. *et* sp.
Fig. 2. Diagram showing structure of *Deltacrinus*. n. gen.
Fig. 3. " " " *Halysiocrinus*, n. gen.

CREMACRINUS, n. gen.

Cheirocrinus, Hall, (non Eichwald.)

Base composed of four anchylosed pieces which together form a sub-triangular or semi-elliptical plate, and to the lower angle of which the round column is attached. Body above the base composed of seven plates, four on the dorsal and three on the ventral side. The dorsal plates are separated from the basal piece by a large number of minute plates, seeming to have been imbedded in an articulating ligament. The lower centro-dorsal plate is more or less narrow and separates the two dorso-lateral plates. The upper central plate varies in form from sub-triangular to transversly oblong-subquadrate, and rests upon the lower central, and the upper sloping faces of the dorso-lateral pieces. The latter are much larger than the central plates, higher than wide, subquadrate or sub-rhomboidal in outline, and curved in their upper half around toward the ventral side. The outer margin of each is concave and articulates with one of the sub-ovate lateral pieces of the ventral side. These two pieces incline toward each other, and with the central piece of this side form an arch that corresponds in outline with the lower margin of the basal plate. The central piece is larger than the sub-oval lateral pieces, wider above than below, and four-sided or hexagonal. It supports a series of large but rapidly diminishing plates that form the posterior side of a long and slender ventral tube. The dorsal arm is strong and simple, and rests upon the upper central piece of the body. The first piece of each of the two lateral rays is supported by the upper side of the dorso-lateral plates. The second piece is axillary and supports two equal arms, which are more or less divided above, the divisions being, however, apparently always unequal.

Type: *C. punctatus,* n. sp.

Cremacrinus punctatus, n. sp.

Body small, compressed antero-posteriorly. Basal piece sub-triangular, nearly three times as wide as high, straight along the upper margin, faintly convex on the lower sides, and pointed at the lateral extremities. It is composed of four unequal and

completely anchylosed pieces; the combined outline of the two small upper pieces, which are separated by an impressed central suture, is about parallel with that of the whole piece. The column is small and round, and attached to the slightly truncated lower end. The space between the basal piece and the dorsal plates is filled by numerous small and irregularly distributed plates. The body above the base is comparatively short, about 0.4 incn wide at a point near the middle of the lower half, 0.3 inch at the top, and about 0.2 inch high.

The dorso-lateral plates are sub-quadrate in outline, with all the margins excepting the upper one slightly curved; the upper half is deflected back toward the ventral side. The convex lower centro-dorsal plate extends nearly to the top of the dorso-lateral pieces, is slightly concave on each side, and strongly so below, where the two sides are drawn down into spine-like prolongations; the lower and inner angle of the dorso lateral plates is similarly prolonged, so that the basal line of these plates forms a sigmoid curve. The lower centro-dorsal plate is about 0.1 inch wide below, very slightly narrower above, and about twice as long. The upper centro-dorsal piece is nearly twice as wide as the lower p'ece, upon which, and the short sloping upper sides of the dorso-lateral plates it rests. It is twice as wide as high, transversely oblong in outline, rather prominent, and apparently, not anchylosed to the other plates of the body. The ventral arch consists of three plates, a sub-triangular central, and one smaller tumid sub-oval plate on each side. Resting on the central piece is the first of a series that supports the long ventral tube. The first and second pieces of this series are large and strongly convex, but the following ones are considerably smaller.

Dorsal arm strong, sub-cylindrical, apparently simple, and composed of pieces that are about as long as wide, and of which six occur in 0.5 inch. The first piece tapers upward and is of the same hight as the succeeding ones. Lateral arms two, one on each side, not as strong as the dorsal ray. The first radial rests upon the upper sloping side of the dorso-lateral plate, and is twice as wide as high. The second is slightly higher, pentagonal, and supports two equal divisions of the ray. Beyond this the arms do not bifurcate, but each second piece throws off

a long slender armlet. These occur alternately on each side of the arm, and give it a slightly zigzag appearance. The arm-pieces are rounded, about as high as wide, and provided with a deep ambulacral furrow within. Entire length of arms at least two inches.

Surface of all the plates covered with rather large and deep punctae, just visible to the unaided eye.

The punctate surface will distinguish this species from the other forms referred to this genus. The centro-dorsal pieces, (especially the lower,) are also large, and the body shorter than in those species. I have seen specimens of a species with similarly punctate plates, from the Trenton limestone at Dixon, Ill. In that species, however, the dorsal arm is much smaller than the lateral ones, while the form of the body and its plates is quite different from those of *C. punctatus*.

The fine specimen from which the above description is drawn, was discovered by Mr. Frank C. Shenahon, and very generously presented by him to the author, in whose cabinet it now is.

Formation and locality: Trenton shales, at Finn's Glen, near Minneapolis, Minn.

DELTACRINUS, n gen.

Basal piece triangular, composed of several anchylosed pieces. Dorsal side of body above the base composed of four more or less firmly united plates. The lower central plate is triangular and entirely separated from the upper triangular piece by the large lateral plates which unite along the central line. Plates of ventral side not determined. Dorsal arm strong, simple or divided. The first piece is the largest and rests upon the upper centro-dorsal plate. The lateral arms are two on each side. The outer one is the strongest, and divides into two equal rays on the second piece. The first plate of the smaller inner arm is cuneate below and rests upon the inner lateral sloping face of the first radial of the outer arm.

Column round, attached to the lower and inner portion of the basal piece.

Type: *Cheirocrinus clarus*, Hall, Hamilton gr.

HALYSIOCRINUS, n. gen.

In the formation of the dorsal side of the calyx, this genus is precisely *Deltacrinus*. The only difference of importance so far detected is found in the number of arms. In *Cremacrinus* we have three primary radials, and in *Deltacrinus* five, while the species for which the above generic term is proposed have eleven,* one large central arm on the dorsal side, and ten smaller ones, the first pieces of which project abruptly outward, and extend in a curved series, transversely around the ventral side. Their inner ends articulate with the ventral arch. All the arms may bifurcate one or more times.

Column round, attached to the slightly truncated lower extremity of the sub-triangular basal piece.

Type: *Cheirocrinus dactylus*, Hall, Burlington limestone.

Aside from *Calceocrinus*, the first notice of American species of this family of crinoids is found in the 13th Regents Report already referred to, in which Hall defines the preoccupied name *Cheirocrinus*, with the following species: *C. chrysalis*, Niagara gr., *C. ventricosus* and *C. dactylus*, Burlington gr., *C. tunicatus* and *C. nodosus* from the Keokuk gr. He also proposed *C. lamellosus*, but until the species for which it is proposed is better described, I am not inclined to recognize the name.† He gives figures of *C. chrysalis*, *C. dactylus* and *C. tunicatus*. In the 15th Regents Report, N. Y., for 1862, he defines and illustrates *C. clarus* from the Hamilton gr., and in 1863, in the Trans. Alb. Inst., vol. iv, *C. stigmatus* is described from the Niagara gr. at Waldron, Ind. Shumard describes *C. perplexus* in 1866, in the Trans. St. Louis Acad. Sci., from strata, supposed to be equivalent to the Keokuk limestone. In 1869, Meek and Worthen describe *C. wachsmuthi* and *C. bradleyi* in the Proc. Acad. Nat. Sci., Phil., the former from the Burlington limestone, the latter from the Keokuk group. Both these species are redescribed and illustrated in vol. v, Geol. Sur., Ill. In 1875, (Geol. Sur., Ill., vol. vi) Worthen describes and figures the body of a Devonian

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*So far as the means at hand will admit the determination of this point, all the species referred to the genus, appear to have had eleven arms. The number of lateral and ventral arms might, however, be found to vary in different species.

†Hall's description reads as follows: "Body unknown. Arms with strong lamellose extensions at the joints. Burlington limestone."

species under the name of *Calceocrinus? barrisi*. In 1882, Ringueberg describes and illustrates, (Jour. Cin. Soc. Nat. Hist., vol. v,) *Calceocrinus radiculus* from the Niagara gr. In the 35th Reg. Rep., N. Y., Walcott illustrates and describes *Calceocrinus barrandei* from the Trenton gr. So far as known to me there are only two other species described from American rocks belonging to the *Cremacrinidae*. These are the *Heterocrinus inaequalis* and *H. articulosus* of Billings from the Trenton rocks of Canada, and described and figured by that author in 1859, in the Can. Org. Rem., Decade iv. Of the sixteen species above enumerated, *C. ventricosus*, Hall, *C. perplexus*, Shumard, *C. barrisi*, Worthen and *H. articulosus*, Billings, are too little known to make their reference to any of the three groups proposed certain, and I leave them in the dubious genus *Calceocrinus*, where they have been placed by Mr. S. A. Miller.* The last is most probably founded upon one of the lateral arms of a *Cremacrinus*, while the others may belong either to *Deltacrinus* or *Halysiocrinus*. The twelve species remaining divide up as follows:

C. chrysalis, Hall, *C. inaequalis*, Billings, *C. barrandei*, Walcott, and *C. radiculus*, Ringueberg, agree with *Cremacrinus punctatus*, Ulrich, in having three primary radials, and the dorso-lateral plates entirely separated by the central pieces. In *C. barrandei* and *C. radiculus* the lower centro-dorsal plate is narrow-wedged shaped, and almost pointed above where it articulates with the upper central piece. This plate is wider in *C. punctatus* than it is in any of the other species here referred to *Cremacrinus*, but the separation of the large dorso-lateral plates is nevertheless complete in all. This character and the limited number of primary radials are the distinguishing features of the genus. All the species are Silurian.

The proposed genus *Deltacrinus* will include *C. clarus*, Hall, the type species, *C. stigmatus*, Hall, *C, bradleyi*, M. & W., and very likely *C. tunicatus*, Hall. These species all agree in having the dorso-lateral plates join along the central line of the body. The lower centro-dorsal plate is wide and depressed triangular, the form being quite different from that of the equivalent piece

*Amer. Pal. Foss., p. 72 and 73.

in *Cremacrinus*. The form of the upper central plate resembles the lower in every particular, excepting that the lateral angles are usually obtuse. The arms are known of *C. clarus* and *C. bradleyi* only, but Hall's figures of *Calceocrinus stigmatus* in the 28th Reg. Rep. N. Y., show the articulating scars for the first arm pieces very distinctly and leave little room to doubt that the arms of that species are like those of *C. clarus*. In this species the arms are primarily five, consisting of the large centro-dorsal one, which may be divided once or remain simple throughout, one somewhat smaller lateral arm on each side, and between each of these and the dorsal arm, one still smaller, and differing from the lateral arms, whose second piece is axillary and supports two equal divisions of the ray, in remaining simple throughout, or, at any rate, for a longer distance. These medio-lateral arms are further peculiar because their first piece rests mainly upon the side of the first radial of the lateral arms. Aside from them the arms of *Deltacrinus* do not differ from those of *Cremacrinus*. They furnish, therefore, one of the principal differences between the two genera.

There are at least three American species that have the characters ascribed to *Halysiocrinus*. These are the *C. dactylus* and *C. nodosus*, Hall, and the *C. wachsmuthi*, M. & W., the first and last from the Burlington limestone, and the second from the Keokuk gr. Beside these the *Cheirocrinus gothlandicus* of Angelin, is an unquestionable member of the genus, and Prof. A. H. Worthen will illustrate in the forthcoming vol. viii, of the Ill. Geol. Sur., two specimens from the Keokuk, which resemble the *C. nodosus*, but may prove specifically distinct. In the construction of the body, and in the possession of a strong dorsal arm, these species do not differ from *Deltacrinus*. The lateral arms, however, differ conspicuously from all the species of both *Cremacrinus* and *Deltacrinus*, in being much more numerous, sub-equal and in extending completely around the ventral side. The primary piece of the first of these lateral arms, and a portion of the first piece of the second, rest upon the upper side of the dorso-lateral plate, while the primary pieces of the remaining six ventral arms project abruptly outward, and their inner surfaces or ends articulate with the anchylosed ventral arch. The ventral arms give to these crinoids a very

different appearance from that presented by the more simple species of *Cremacrinus* and *Deltacrinus*. In my opinion they constitute an important deviation from the types of those genera, and fully warrant generic separation. The range of the genus is from the upper Silurian, (*H. gothlandicus*, Ang. sp.,) to the Keokuk group. The Devonian formation is, however, not represented, the other species of the genus known being all from sub-carboniferous deposits.

According to the classification here proposed, the species discussed will be arranged as follows:

CREMACRINIDAE, n. fam.

CREMACRINUS, n. gen.

C. punctatus, Ulrich. Trenton group. (type of genus.)
C. inaequalis, Billings. " "
C. barrandei, Walcott. " "
C. radiculus, Ringueberg Niagara, gr.
C. chrysalis, Hall.

DELTACRINUS, n. gen.

D. clarus, Hall. Hamilton gr. (Type of genus.)
D. stigmatus, Hall. Niagara gr.
D. bradleyi, Meek and Worthen, Keokuk gr.
D.? tunicatus, Hall.

HALYSIOCRINUS, n. gen.

H. dactylus, Hall, Burlington gr. (Type of genus.)
H. wachsmuthi, M. & W. Burlington gr.
H. nodosus, Hall, Keokuk gr.
H. gothlandicus, Angelin, Upper Silurian.

CALCEOCRINUS? Hall.

C. articulosus, Billings, Trenton gr.
C. barrisi, Worthen, Hamilton gr.
C. ventricosus, Hall, Burlington limestone.
C. perplexus, Shumard, Keokuk gr.

IV.

CONCHOLOGICAL NOTES.

BY U. S. GRANT.

A number of shells from various parts of the state have been collected by the geological and natural history survey at different times, but no attempt has been made to obtain a series of specimens illustrating the molluscan fauna of the state. The shells thus obtained were unpacked and classified during the last summer. They are mostly bivalves and are all "dead," thus furnishing only a few good museum specimens, but giving a number of localities. Last summer one week was spent by the writer in collecting in the vicinity of Minneapolis; a few species were added to the collection already obtained, but no thorough search was made; if more time could have been used a much larger number of species probably would have been found. Hennepin county does not seem to be a good locality for land forms and very few were obtained. There are now some eighty species in the University Museum.

The writer wishes to obtain for the survey as many specimens as possible representing different localities. Any shells, even the most common, will be gladly received, and there are quite a number of duplicates to exchange with those who desire. Any of our lakes will furnish several species, and on the muddy banks and sand-bars of the rivers can be found large numbers of fresh-water clams. At low water the sand-bars will in some places be almost covered with dead shells; the live ones will be found in muddy more commonly than in sandy bottoms. As an example of the abundance of fresh-water mollusks in this state, it can be said that thirty species were found in the Minnesota river at Ft. Snelling, and very likely more could have been procured by farther search. It is probable that other rivers of the state can furnish as large a number of species as the Minnesota.

In the following an attempt has been made to give the species so far collected, and the localities, especially those most widely separated. All species and localities can be referred to specimens in the University collection or in that of the writer. It is hoped that more interest may be taken in the shells of the state and that the survey may be aided in acquiring a complete series of the mollusks of Minnesota.

The survey is indebted to the kindness of professor R. Ellsworth Call for the classification of most of the Unionidæ. Descriptions of all of this family could not be easily obtained, and even if the necessary books were handy, the aid of a specialist would be needed in the classification of this family. Prof. Call has also kindly helped in the verification of some of the gasteropoda.

LAMELLIBRANCHIATA.

Family UNIONIDÆ.

Anodonta corpulenta, Cooper—Five or six specimens were obtained in the Minnesota river at Ft. Snelling; only one of them was adult; this approaches *A. grandis* in size, but is much higher in proportion to its length than is *A. grandis*; this specimen is 4 inches high and $5\frac{3}{4}$ in length. 1496. (These numbers refer to the Zoological Register of the museum.)

Anodonta edentula, Say.—Red river, Wilkin county, and Minnesota river at Granite Falls. This shell is heavier in proportion to its size than any of our other species of this genus. 1441, 1548.

Anodonta ferussaciana, Lea.—Only one specimen has been collected and this was found in the Rum river at Anoka; it measures $1\frac{1}{2}$ inches in length and $\frac{13}{16}$ in hight. 1511.

Anodonta grandis, Say.—Rollingstone creek, Minnesota City, and Zumbro river, Wabasha county. This is the largest species of the genus found in Minnesota; it will probably be found quite commonly in some localities. 1589, 1590.

Anodonta imbecilis, Say.—Very abundant in the Minnesota river at Ft. Snelling; a very pretty fragile shell with bright green epidermis, sometimes having faint darker green radiations; the largest specimens found are nearly $2\frac{3}{4}$ inches long. 1497.

Margaritana complanata, Barnes.—One young shell was found

in the Minnesota river at Ft. Snelling. This species grows to be very large, sometimes measuring over 17 inches in circumference, and not more than 2 inches in width. 1498.

Margaritana confragosa, Say.—This peculiar species has been found only in the Minnesota river at Ft. Snelling; two young specimens were procured and one very fine adult, which is 4½ inches long and 3½ inches high. This locality is believed to be the most northern from which the shell has been reported, and the first time from Minnesota. 1493.

Margaritana marginata, Say.—Found in the Minnesota river at Granite Falls, and the Mississippi at Ft. Snelling; no full grown specimens are yet in the museum. 1540.

Margaritana rugosa, Barnes—Only one specimen is in the museum; this is about one third grown and was found in the Minnesota river at Granite Falls. The posterior end of this species has a number of peculiar folds that are more distinct near the top of the shell; the nacre is usually of a delicate cream-color. 1541.

Unio æsopus, Green.—Common in the Mississippi river, Dresbach, Winona county. This shell is characterized by a single row of elongated tubercles on each valve extending from the umbone to the lower margin; these tubercles are more in number and not so conspicuous as those on *U. cornutus*. 1480.

Unio alatus, Say.—Red river, Wilkin county; Mississippi river, Winona county; lake Pepin; common in the Minnesota river at Granite Falls and at Ft. Snelling. Three alate species of this genus have been found in the state, *alatus*, *lævissimus*, and *gracilis*; the first two have a red nacre and are of nearly the same size, but the first is a much heavier shell and has stronger teeth; *U. gracilis* is smaller than the others, the epidermis is much lighter in color and is rayed with green, and the red nacre is generally confined to the dorsal portion of the shell. These three species occur quite commonly in the Minnesota river at Ft. Snelling, but more specimens of the last were procured than of the others. 1436, 1472, 1495, 1542.

Unio anodontoides, Lea.—Very abundant in the Minnesota river at Ft. Snelling. A pretty, long, salmon-colored shell; the epidermis has a number of dark rays, but sometimes the rays are nearly obsolete. 1505.

Unio cornutus, Barnes.—Lake Pepin; Mississippi river, Winona county; Minnesota river, Ft. Snelling. This species has not been found very abundantly, but is quite common in Lake Pepin; it is easily recognized by a row of large tubercles on each valve; they extend from the umbone to the lower margin and the largest are raised about a quarter of an inch from the surface of the shell. (See *U. æsopus.*) 1430, 1481, 1506.

Unio ebenus, Lea.—Very abundant in the Mississippi river at Dresbach, Winona county, but has not been found elsewhere. 1484.

Unio elegans, Lea.—Only one specimen is in the museum, and this came from the Minnesota river at Ft. Snelling. A very pretty shell with numerous radiations. 1500.

Unio ellipsis, Lea.—Common in the Mississippi river at Dresbach, Winona county. 1482.

Unio gibbosus, Barnes.—Minnesota river at Ft. Snelling; not common. This species is similar in shape to *U. rectus*, but can be distinguished from it by the coarser undulations on the umbones and by the heavier lateral teeth. The nacre is usually red. 1504.

Unio gracilis, Barnes.—Abundant in the Minnesota river at Ft. Snelling. This shell is oblong and quite fragile and has a light-olive epidermis. The largest specimens obtained are 4½ inches long. (See *U. alatus.*) 1499.

Unio graniferous, Lea.—One dead shell was found in the Mississippi river at Ft. Snelling. 1533.

Unio Lacrymosus, Lea.—Two specimens are in the museum; one from the Red river, Wilkin county, and the other from the Minnesota river, Ft. Snelling. The latter is 2⅝ by 2¼ in. 1435, 1518.

Unio lævissimus, Lea.—Common in the Minnesota river at Ft. Snelling. The shell is very thin and has a shining epidermis. (See *U. alatus.*) 1494.

Unio ligamentinus, Lamarck. Lake Pepin; Mississippi river, Winona county; common in the Minnesota river at Granite Falls. The specimens from Winona county are very heavy: the largest is 5 inches long. 1477, 1545.

Unio luteolus, Lamarck.—Mississippi river, Brainerd; lake Minnewaska, Pope county; White Bear lake; Minnehaha creek,

Hennepin county; Red river, Wilkin county; Mississippi river, Winona county; Rollingstone creek, Minnesota city; lake Minnetonka; Minnesota river, Ft. Snelling; Mississippi river, Anoka county; Rum river, Anoka. This is our most common species and is usually found very abundantly. It is extremely variable. Those found in the lakes in the vicinity of Minneapolis are quite small, fragile, and much eroded, and the radiations are nearly obsolete. The heaviest and largest yet found are from Ft. Snelling; some of these are 5 inches long. The young shells are very beautifully rayed with green. 1423, 1425, 1434, 1443, 1454, 1474, 1485, 1491, 1502, 1509, 1512, 1569.

Unio metanerous, Rafinesque.—Mississippi river, Dresbach, Winona county; Minnesota and Mississippi rivers, Ft. Snelling; rather common in Lake Pepin. This shell has a large ridge extending from the umbones to the basal posterior margin. 1476.

Unio occidens, Lea.—Rather common in the Mississippi river at Dresbach, Winona county. 1478.

Unio parvus, Barnes.—About a dozen specimens were found in the Minnesota river at Fort Snelling; the largest is less than an inch long. This is the smallest species of the genus yet found in the state. 1508.

Unio plicatus, Le Sueur.—Mississippi river, Dresbach, Winona county; Minnesota river at Ft. Snelling and Granite Falls; Lake Pepin. Rather common in these localities. (See *U. undulatus.*) 1473, 1517, 1546.

Unio rectus, Lamarck.—Mississippi river, Brainerd; Red river, Wilkin county; Rum river, Anoka county; Minnesota river, Granite Falls; Mississippi river, Winona county. This species is common and in some places abundant. It is a long straight shell; some of the adults are 5½ in. long and 2½ high. (See *U. gibbosus.*) 1422, 1433, 1503, 1546.

Unio rubiginosus, Lea.—One specimen from the Red river, Wilkin county, is in the museum. 1437.

Unio securis, Lea.—Lake Pepin; Mississippi and Minnesota rivers at Ft. Snelling. Not common, a very pretty straw-colored shell with fine radiations and dark blotches, which are arranged in rows from the umbones to the lower margins. 1516.

Unio solidus, Lea.—One specimen was found in the Mississippi river at Ft. Snelling. 1513.

Unio trigonus, Lea.—Common in lake Pepin and in the Minnesota river at Ft. Snelling. The largest specimens are 2½ inches by 2. 1521.

Unio tuberculatus, Barnes.—Minnesota river at Granite Falls and at Ft. Snelling; Mississippi river, Dresbach, Winona county. This species has not been found to be very common in the localities named. Almost the entire shell, except the posterior portion, is covered with small tubercles. The largest specimen is 5 inches long and 2⅝ high. 1514, 1543, 1588.

Unio undulatus, Barnes.—Common in the Red river, Wilkin county. This shell resembles *U. plicatus*, but is much thinner; it will probably be found to be rather common. The posterior half of the shell is covered with undulations that run from the umbones obliquely to the lower and posterior margins; these undulations also exist on *U. plicatus*. 1442.

Unio ventricosus, Barnes.—Mississippi river, Brainerd; Red river, Wilkin county; Rum river, Anoka county; Minnesota river at Granite Falls and Ft. Snelling. This is a very common species and widely distributed. The specimens from the Rum river are dark-colored and beautifully rayed with green, while those from the Red river are straw-colored and the radiations are nearly obsolete. 1424, 1439, 1510, 1515, 1544.

Unio zigzag, Lea.—Rather common in the Minnesota river at Ft. Snelling; the largest specimen is 1 inch long and $\frac{11}{16}$ high. This is a very pretty little shell beautifully marked with dark-green. 1501.

CORBICULADÆ.

Sphærium occidentale, Prime.—This species has been found only at Minneapolis, and is not at all common. This family contains quite small bivalves; those found in Minnesota are usually less than half an inch long. 146.

Sphærium partumeium, Say.—Found only at Minneapolis. 1566.

Sphærium rhomboideum, Say.—Only one specimen in the museum; this came from lake Bertram, Wright county. 1565.

Sphærium striatinum, Lamarck.—This species is so far found to be the most common of the genus in this state; it is very common in Minnehaha creek; Minnesota river at Ft. Snelling; and Mississippi and Rum rivers, Anoka county; two specimens

were obtained in lake Bertram, Wright county. This species varies considerably in size, color and thickness; one of the specimens from Wright county is much the largest in the museum; it measures $\frac{5}{8}$ inch in length. 1537, 1538, 1564.

Sphærium transversum, Haldeman.—Common in the Minnesota river at Ft. Snelling. This is the smallest bivalve yet found in the state, being only .15 inch long. 1520.

GASTEROPODA.

HELICIDÆ.

Hyalina arborea, Say—Quite common in the vicinity of Minneapolis; found associated with *Patula striatella*. It is a pretty shining little shell, measuring about $\frac{3}{16}$ of an inch in diameter. 1459.

Helicodiscus lineatus, Say.—Rather common in Hennepin county. This is a small flat shell with one or two small white teeth within the mouth. 1438.

Patula alternata, Say.—Common in Hennepin county; under stones on Nicollet island this shell is very abundant. This is our only large Helix that has reddish-brown blotches on the epidermis; adult specimens are $\frac{3}{4}$ inch in diameter. 1432.

Patula striatella, Anthony.—This is the most abundant land shell in Hennepin county. It is found in almost every damp place under chips and logs; some of the larger specimens are .23 inch in diameter. The surface of the shell is covered with ribs. 1534.

Strobila labyrinthica, Say.—Rather common in Hennepin county. Most of the specimens collected are "dead" shells. 1455.

Stenotrema monodon, Rackett.—Two specimens have been found on the University campus; the largest is .35 inch in diameter. This is a brown shell and quite thick for its size; there is a long narrow white tooth on the inside edge of the mouth. 1461.

Mesodon multilineata, Say.—Found near White Bear lake; common in the vicinity of Minneapolis. This shell is readily distinguished from all others of the family in this state by its size and by the numerous revolving reddish-brown lines. Two specimens were found entirely lacking the revolving lines. This

species can be found crawling about on the ground in damp woods. 1449, 1466.

Vallonia pulchella, Muller.—Found very abundantly under logs on one corner of the University campus, but has not been found elsewhere. This is a small white shell, almost transparent, and the lip is thick and quite broad. The largest specimens are a little more than $\frac{1}{10}$ inch in diameter. 1469.

Cionella subcylindrica, Linnæus.—About twenty specimens have been found near Minneapolis. This is one of our prettiest land shells; the epidermis is shining light-brown, and there is a reddish line on the lip. The shell is .26 inch long and .08 in diameter. 1470.

Succinea obliqua, Say.—Only collected at Minneapolis, where it has so far been found to be rather rare. This species and the next are very pretty delicate shells; sometimes they are found in great numbers on the under sides of the leaves of large weeds. This shell varies from amber-colored to pale, yellowish-green; sometimes the apex has a slight tinge of red, but no specimens in the museum are thus colored. It is the largest shell of this genus found in Minnesota; the largest specimen collected is over three fourths of an inch long. 1467.

Succinea ovalis, Gould.—Found as yet only in Hennepin county, not so rare as the preceding, but still not common. It is much more elongated and delicate than *S. obliqua*, and has a more beautiful amber color. This shell is found on the borders of streams and ponds in damp shady places. The largest shell of this species in the museum is $\frac{6}{10}$ of an inch long. 1468.

AURICULIDÆ.

Carychium exiguum, Say.—The smallest shell yet found in the state; it measures only .07 in. in length and .03 in diameter. This shell has been mistaken many times for a shell belonging to the genus *Pupa*, but the animal is very different. It is found in damp places under logs, chips, etc. It has been collected only on the University campus, where, after more than three hours patient and diligent search, less than a dozen specimens were found. The shell is white and very thin, and there is a small tooth on the body-wall of the aperture. No other species of this family is found far away from the sea coast. 1568.

LIMNÆIDÆ.

Limnæa stagnalis, Linnæus.—Found at Minneapolis; lake Minnewaska, Pope county; White Bear lake; lake Bertram, Wright county; Minnesota river at Granite Falls and Ft. Snelling; and in the vicinity of Rainy river. This is one of the shells that is found in the northern parts of both Europe and America. It is rather fragile for so large a shell; some individuals found at Minneapolis are two inches long. This shell is a common species and, where it occurs, is generally found in large numbers. The animal is nearly black and can be easily pulled out of the shell. 1427, 1431, 1446, 1450, 1507, 1550.

Bulimnea megasoma, Say.—A fine shell and rather heavy, with chestnut-brown within the aperture and sometimes having green stripes on the larger whorls. Two specimens from Knife lake, on the northern state boundary, are in the museum.

Limnophysa reflexa, Say.—Found in the lakes about Minneapolis; also at White Bear lake and Lake City. This shell is very long and slim, sometimes measuring $1\frac{6}{10}$ inches in length and $\frac{9}{20}$ in diameter. 1444, 1455, 1456.

Limnophysa caperata, Say.—Abundant in the vicinity of Minneapolis, but no specimens have been received from other parts of the state. Running around the shell are numerous fine lines which can be seen with the aid of a pocket lens. 1581.

Lymnophysa palustris, Muller.—Found in Lake Minnetonka. This is another form that is common to both Europe and America. It is very variable and has a large synomony. The shells found in lake Minnetonka correspond to *L. elodes*, Say.

Physa gyrina, Say.—Minneapolis; Rum river, Anoka; Mississippi river at Anoka and Ft. Snelling. Very common and in some places abundant.—Specimens vary from dark-brown to light-brown. 1452, 1576, 1577, 1578.

Physa heterostropha, Say.—Cedar lake, Minneapolis; Minnehaha creek; Mississippi river at Anoka and Ft. Snelling. This is much prettier and more abundant than the preceding species. The specimens collected are rather small. 1457, 1463, 1522, 1539.

Bulinus hypnorum, Linnæus.—Common in one pond near Minneapolis, but has not been found elsewhere. This is a fragile, shining, dark-brown shell. The animal is black. This species

is found in Europe and America. The largest specimens are $\frac{3}{4}$ inch long and $\frac{6}{20}$ inch in diameter. 1465.

Planorbella campanulata, Say.—Lake Minnetonka; White Bear lake; Minneapolis; Wright county. A very common shell, abundant in some places. Some specimens from Wright county are nearly $\frac{3}{4}$ of an inch in diameter. 1429, 1447, 1462, 1464, 1489, 1552, 1574, 1592.

Helisoma bicarinatus, Say.—Minneapolis; lake Minnewaska, Pope county; Wright county. Common but not so much so as the preceding species. One specimen is over $\frac{3}{4}$ of an inch in diameter; but this shell does not usually grow to be so large. 1428, 1453, 1553, 1591.

Helisoma trivolvis, Say.—Minnesota river at Granite Falls and Ft. Snelling; Minneapolis; White Bear lake; along the northern boundary. Very common. The specimens found in one pond near Minneapolis are extremely black; large shells from Ramsey county are over an inch in diameter. This species varies greatly in size. 1448, 1451, 1549, 1554, 1570, 1571, 1572, 1573.

Gyraulus deflectus, Say.—Very common in the lakes about Minneapolis; also found in lake Bertram, Wright county. This is a small flat species with the aperture bent down below the centre of the shell—whence the name. The largest specimens are $\frac{5}{16}$ inch in diameter, and about $\frac{1}{12}$ inch high. 1575, 1582.

VALVATIDÆ.

Valvata tricarinata, Say.—Very common in the lakes of Wright and Hennepin counties. This shell is easily distinguished by its three raised revolving lines, one on the upper edge of the whorl, one on the lower, one on the base. The largest specimen in the museum is from Buffalo lake, Wright county, and is nearly a quarter of an inch in diameter. This species and the preceding are found clinging to the plants in the shallow water of our lakes. 1460, 1555, 1593.

VIVIPARIDÆ.

Vivipara intertexta, Say.—This shell seems to be very common in White Bear lake, but has not been found elsewhere. It is the only species of this genus found as yet in Minnesota. 1445.

Melantho decisa, Say.—Binney gives both *M. subsolida*, Auth. and *rufa*, Hald. as synonyms of this species; the latter has been

found common in the Rum river, Anoka county, the former is common in the Minnesota river at Ft. Snelling, and abundant in the Mississippi river at Minneapolis. The largest specimens are about 1½ inches high and ¾ in diameter.

Lioplax subcarinata, Say.—Rather common in the Minnesota river at Ft. Snelling and found associated with the preceding species. No large individuals were found. The specimens vary from sharply carinated ones to those with no appreciable carinæ. 1486.

RISSOIDÆ.

Bythinella obtusa, Lea.—Common in the Minnesota river at Ft. Snelling, but not found elsewhere. This and the three following species are found in the mud on the banks of rivers; they can be collected by getting a sieve full of the mud and then washing it out with water; sometimes quite a quantity of shells will be left in the sieve. This species is about .14 inch long. 1535.

Somatogyrus subglobosus, Say.—Abundant in the Minnesota river at Ft. Snelling. No specimens from any other locality are in the museum. The shell is rather thin and when cleaned is of a light horn-color, sometimes with a reddish tinge on the apex. The largest specimens are .22 inch high and .19 in diameter. 1471.

Amnicola cincinnatensis, Anthony.—Common in the Minnesota river at Ft. Snelling and the Rum river, Anoka County. This species is thicker and larger than the following. One specimen from the Rum River is a quarter of an inch long. 1584, 1585.

Amnicola porata, Say.—Common in the Minnesota river at Ft. Snelling, and in the lakes near Minneapolis. This shell is quite thin and nearly transparent. 1586, 1587.

STREPOMATIDÆ.

Pleurocera subulare, Lea.—This is the only species of this family yet found by the survey in Minnesota. It is very common in the Minnesota river at Ft Snelling, and in the Mississippi and Rum rivers, Anoka county. Specimens from the Minnesota river are smaller than the others and the shell is not so thick; those found in the Rum river are very large, old, and much eroded; several are over ¾ inch long. 1531, 1532, 1583.

V.

REPORT ON THE MUSEUM FOR 1885.

SPECIMENS REGISTERED IN THE GENERAL MUSEUM IN 1885.

Serial Number.	OBTAINED. When.	OBTAINED. Whence.	NAME.	No. of Specimens	Locality.	Formation.	Collector and Remarks.
5773	May, 1885.	Exchange	Platystoma peoriense, McCh	2	Peoria Co, Ill.		From W. H. Adams.
5774	"	"	Spirifera lineata, Morton	10	" "		" "
5775	"	"	Spirifera camerata, Morton	1	Knox Co., Ill		" "
5776	"	"	Spiriferina kentuckiensis, Sh	4	Peoria Co. Ill		" "
5777	"	"	Rhynchonella illinoiensis, Worth	5	" "		" "
5778	"	"	Rhynchonella metallica, White	2	" "		" "
5779	"	"	Rhynchonella uta, Marcou	6	Peoria and Knox Co's Ill.		" "
5780	"	"	Chonetes mesoloba, N. & P.	5	" " "		" "
5781	"	"	Chonetes parva, Sh	15	" " "		" "
5782	"	"	Pleurotomaria grayvillensis, N. & P.	3	" " "		" "
5783	"	"	Pleurotomaria subturbinata, Meek & H	1	Peoria Co., Ill.		" "
5784	"	"	Athyris subtilita, Hall	9	" "		" "
5785	"	"	Athyris royissii	2	" "		" "
5786	"	"	Retzia mormoni, Marcou	8	" "		" "
5787	"	"	Lophophyllum proliferum, McCh	21	Peoria and Knox Co's Ill.		" "
5788	"	"	Cyathaxonia distorta, Worth	3	Peoria Co., Ill		" "
5791	"	"	Productus muricatus, N. & P.	10	Knox Co., Ill		" "
5792	"	"	Pleurotomaria illinoiensis	1	" "		" "
5793	"	"	Productus nebrascensis, Owen	1	" "		" "
5794	"	"	Productus prattenianus, Norwood	5	" "		" "
5795	"	"	Nucula ventricosa, Hall	2	" "		" "
5796	"	"	Bellerophon carbonarius, Cox	4	Peoria and Knox Co's Ill		" "
5797	"	"	Bellerophon montfortanus, N. & P	4	Knox Co., Ill		" "
5798	"	"	Terebratula bovidens, Morton	2	" "		" "
5799	"	"	Petrodus occidentalis, N. & W	1	Peoria and Knox Co's Ill.		" "
5800	"	"	Discina nitida, Phillips	1	Knox Co., Ill		" "
5801	"	"	Nautilus decoratus, Cox	1	" "		" "
5802	"	"	Trachydomia nodulosa, Worth	7	Peoria Co., Ill		" "
5803	"	"	Streptorhynchus crassus, M. & H	4	Peoria and Knox Co's, Ill.		" "
5804	"	"	Phillipsia scitula, M. & W.	1	Peoria Co., Ill.		" "
5805	"	"	Fusulina cylindrica, Fiss	9	Peoria and Knox Co's, Ill.		" "

5806	"	"	Macrocheilus primigenius, Cour	2	Peoria Co., Ill		"	"
5808	"	"	Trigonocarpus adamsi, Lesq	16	West Jersey, Stark Co, Ill.		"	"
5809	"	"	Carpolithes perpussillus	5	" " "		"	"
5810	"	"	Trigonocarpus starkianus, Lesq	6	" " "		"	"
5811	"	"	Rhabdocarpus mammillatus, Lesq	6	" " "		"	"
5812	"	"	Trigonocarpus noeggerathi, Brgt	1	" " "		"	"
5813	"	"	Trigonocarpus dawsi, L. & H	1	" " "		"	"
5863	"	Geol Survey	White clay	1	Red Wing, Minn.		N. H. Winchell.	
5864	March, 1885.	Presented	Tufaceous deposit	1	Yellowstone Nat. Park		From Prof. H. S. Baker, St. Paul.	
5866	June, 1885.	"	Oriskany sandstone	1	Schoharie, N. Y		" Chas. E. Hall.	
5867	"	"	Magnetite and Apatite	1	Mineville, Essex Co., N.Y.		" "	"21 Bed" Mine.
5868	"	"	Specular iron ore	1	Rossie, St. L. Co., N. Y.		" "	Caledonia Mine.
5869	"	"	Red slate	1	Middle Granville, Wash. Co., N Y		" "	Primordial slate.
5870	"	"	Utica slate (with graptolites)	2	Holland Patent, N. Y		" "	
5872	"	"	Oriskany sandstone	1	Oriskany Falls, N. Y		" "	
5873	"	"	Coralline limestone	1	Schoharie, N. Y		" "	
5874	"	"	Variegated slate	1	Middle Granville, Wash. Co., N Y		" "	Primordial slate.
5875	"	"	Plumbago	1	Ticonderoga, Essex Co., N. Y		" "	Old lead mine.
5876	"	"	Clinton ferruginous sandstone	1	Ilion, N. Y.		" "	
5877	"	"	Magnetite and Mica	1	Crown Point, Essex Co., N. Y.	Lower Lau	" "	
5878	"	"	Birdseye limestone (with fucoid)	1	Canajoharie, N. Y		" "	
5880	"	"	Gray sandstone	1	Ilion, N. Y.		" "	
5881	"	"	Water lime	1	Manlius N. Y.		" "	
5882	"	"	Chazy limestone	2	Isle La Motte, N. Y.		" "	
5883	"	"	Labradorite	1	Little Falls, N. Y		" "	
5885	"	"	Calciferous sandstone	2	" "		" "	
5886	"	"	Gneiss	1	Rossie, St. Law. Co., N.Y.		" "	Rocks associated with galena.
5887	"	"	Labradorite	1	Little Falls, N. Y		" "	
5889	"	"	Tentaculite limestone	1	Schoharie, N. Y		" "	
5890	"	"	Vein rock	1	Rossie, St. Law. Co., N.Y.		" "	" "
5891	"	"	Sandstone	1	Potsdam, N. Y	Potsdam	" "	
5892	"	"	Schoharie grit	1	Schoharie, N. Y		" "	
5893	"	"	Calciferous sandstone	2	Little Falls, N. Y		" "	Showing bituminous matter, quartz & calcite.
5894	"	"	Labradorite	1	" "		" "	
5895	"	"	Labradorite	1	" "		" "	
5896	"	"	Breccia	1	Rossie, St Law. Co, N.Y.		" "	Caledonia mine.
5897	"	"	Primordial limestone	1	Swanton Vt.		" "	
5898	"	"	Goniatite limestone	1	Schoharie, N. Y		" "	
5899	"	"	Purple slate	1	Middle Granville, N. Y		" "	
5900	"	"	Gray garnetiferous gneiss	1	Saratoga Co., N. Y		" "	

Specimens registered in the General Museum in 1885.—*Continued.*

Serial Number.	OBTAINED. When.	OBTAINED. Whence.	NAME.	No. of Specimens.	Locality.	Formation.	Collector and Remarks.
5901	June, 1885	Presented	Gneiss	1	Crown Point, Essex Co., N. Y.		From Chas. E. Hall.
5902	"	"	Magnetite	1	Mineville, Essex Co., N. Y.		" " New bed mine.
5903	"	"	Calciferous sandstone	1	Little Falls, N. Y		" "
5904	"	"	Labradorite	1	" "		" "
5906	"	"	Cauda Galli grit	1	Clarksville, Albany Co., N Y.		" "
5907	"	"	Marble	1	Gouverneur, N. Y.		" "
5908	"	"	Magnetite	6	Mineville, Essex Co., N. Y.		" " New bed mine.
5909	"	"	Rock associated with ore	3	Gilboa, N. Y.		" "
5911	"	"	Quartz crystals	25	Little Falls, N. Y		" "
5912	"	"	Sample of building stone	1	Potsdam, N. Y.	Potsdam	" " Cube of sandstone, 1 ft. sq.
5913	"	Geol. Survey	Sample of building stone (1 ft x 1ft. x6 in.)	1	Mankato, Minn.	St. Law	N. H. Winchell from Fowler & Ring.
5914	"	"	" " " "	1	" "	"	N. H. Winchell from W. B Craig & Co.
5915	"	"	" " " "	1	" "	"	" "
5916	"	"	" " " "	1	" "	"	" "
5917	"	"	Sample of building stone (pink)	1	Kasota, Minn	Shak.	" from C. W. Babcock's quarries.
5918	"	"	Sample of building stone (white)	1	" "	"	" "
5919	July, 1884	"	Hematite	Ind.	Tower City, Vermilion lake, Minn.		" Breitung mine.
5920	"	"	Hematite	"	" " "		" Stone "
5921	"	"	Hematite	"	" " "		" Breitung "
5922	"	"	Repressed brick	6	Dresbach, Minn		" from Sherwood & Johnson.
5923	1884	Presented	Red quartzyte (striated)	1	Pipestone City, Minn		C. H. Bennett.
5924	1877	Geol. Survey	Stomatopora inflata, Hall	1	Minneapolis, Minn	Trenton	N. H. Winchell. From 5537.
5925	1885	"	Berenicea minnesotensis, Ulrich	1	" "	"	E. O. Ulrich.

5926	1876-1879	"	Ropalonaria pertenuis, Ulrich	1	" "	Trenton shales.	C. L. Herrick. Attached to Pachydictya foliata, Ul.
5927	1880	"	Arthroclema pulchellum, Bill	1	St. Paul, Minn	Trenton	N. H. Winchell.
5928	1885	"	Helopora divaricata, Ulrich	1	Minneapolis, Minn	Trenton shales.	E. O. Ulrich.
5929	"	"	Ptilodictya subrecta, Ulrich	1	" "	"	"
5930	"	"	Ptilodictya ramosa, Ulrich	1	" "	"	"
5931	"	"	Ptilodictya nodosa, Hall	1	" "	"	"
5932	"	"	Arthropora shaffen, Meek	1	" "	"	"
5933	"	"	Arthropora simplex, Ulrich	1	" "	"	"
5934	"	"	Stictopora fenestrata (?) Hall	1	" "	"	"
5935	"	"	Stictopora paupera, Ulrich	1	" "	"	"
5936	"	"	Stictopora fidelis, Ulrich	1	" "	"	"
5937	Sept. 1880.	"	Stictopora fidelis, Ulrich	1	Near Lanesboro, Minn	"	N. H. Winchell. From 4030.
5938	1885	"	Stictopora mutabilis, Ulrich	1	Minneapolis, Minn	"	E. O. Ulrich.
5939	Aug. 1877.	"	Stictopora mutabilis	1	St. Paul, Minn	"	N. H. Winchell. From 2562.
5940	1885	"	Stictopora mutabilis, var. major	1	Minneapolis, Minn	"	E. O. Ulrich.
5941	"	"	Stictopora mutabilis, var. minor	1	" "	"	"
5942	1876-1879	"	Phaenopora multipora	1	" "	"	C. L. Herrick. From 5125.
5943	1885	"	Stictoporella angularis, Ulrich	1	" "	"	E. O. Ulrich.
5944	"	"	Stictoporella cribrosa, Ulrich	1	" "	"	"
5945	1882	"	Stictoporella frondifera, Ulrich	1	Sec. 6, Fremont, Winona Co., Minn	"	Presented by W. H. Shelton. From 4671.
5946	1876-1879	"	Stictoporella frondifera	1	Minneapolis, Minn	"	C. L. Herrick From 5125.
5947	1885	"	Stictoporella frondifera	1	" "	"	E. O. Ulrich.
5948	"	"	Pachydictya foliata, Ulrich	1	" "	"	"
5949	1880	"	Pachydictya occidentalis, Ulrich	1	St. Paul, Minn	"	N. H. Winchell. From 5538.
5950	1885	"	Pachydictya fimbriata, Ulrich	1	Minneapolis, Minn	"	E. O. Ulrich.
5951	Aug., 1877.	"	Pachydictya fimbriata (?)	1	St. Paul, Minn	"	N. H. Winchell.
5952	Aug., 1883.	Presented	Pachydictya conciliatrix, Ulrich	1	Cannon River Falls, Goodhue Co., Minn	Trenton	Presented by W. H. Scofield. From 5303.
5953	1885	Geol. Survey	Phyllodictya frondosa, Ulrich	1	Minneapolis, Minn	Trenton shales.	E. O. Ulrich.
5956	1880	"	Stictopora mutabilis, Ulrich	1	St. Paul, Minn	"	N. H. Winchell. From 5338.
5957	"	"	Stictopora mutabilis	1	" "	"	" very old. From 5338.
5958	1885	"	Crepipora impolita, Ulrich	1	Minneapolis, Minn	"	E. O. Ulrich.
5959	1873	"	Crepipora impolita	1	Minneapolis, Minn, (Finn's Glen)	"	N. H. Winchell. From 330.
5960	Aug., 1877.	"	Crepipora impolita, Ulrich	1	Minneapolis, Minn	"	C. L. Herrick. From 797.
5961	Sept., 1880.	"	Crepipora impolita	1	Near Lanesboro, Minn	"	N. H. Winchell. From 4036.
5962	1876-1879	"	Crepipora impolita	1	Minneapolis, Minn	"	C. L. Herrick. From 5123.
5967	1885	"	Monticulipora wetherbyi, Ulrich	1	" "	Chazy (?)	E. O. Ulrich.
5968	"	"	Monticulipora incompta, Ulrich	1	" "	Trenton shales.	"
5969	"	"	Monticulipora grandis, Ulrich	1	" "	"	"
5970	"	"	Homotrypa minnesotensis, Ulrich	1	" "	"	"
5971	1882	"	Homotrypa minnesotensis	1	" "	"	N. H. Winchell. From 4937.
5972	Sept., 1880	"	Homotrypa minnesotensis	1	Near Lanesboro, Minn	"	" " 4036.
5973	"	"	Homotrypa minnesotensis	1	Near Fountain, Minn	"	" " 4050.

Specimens registered in the General Museum in 1885.—Continued.

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5974	1882	Geol. Survey. ..	Homotrypa minnesotensis	1	Minneola, Goodhue Co., Minn	Trenton shales.	N. H. Winchell. From 4996.
5975	1876-1879	"	Homotrypa minnesotensis	1	Minneapolis, Minn	"	C L. Herrick. " 5123.
5976	1885	"	Homotrypa exilis, Ulrich	1	" "	"	E. O. Ulrich.
5977	Aug., 1877.	"	Homotrypa insignis, Ulrich	1	St. Paul, Minn	"	N. H. Winchell. Type. From 2578.
5978	1885	"	Homotrypa insignis (?)	1	Minneapolis, Minn	"	E. O. Ulrich.
5979	1880	"	Homotrypa insignis (?)	1	Near Fountain, Minn	"	N. H. Winchell. From 3539.
5980	1882	"	Homotrypa subramosa, Ulrich	1	Minneola, Goodhue Co., Minn.	"	" " 4996.
5981	Oct., 1875.	"	Homotrypella instabilis, Ulrich	1	Fillmore, Fillmore Co., Minn	"	" " 259.
5982	1876-1879	"	Homotrypella instabilis	1	Minneapolis, Minn	"	C. L. Herrick. " 5123.
5983	Aug., 1877.	"	Atactoporella occidentalis, Ulrich	1	St. Paul, Minn	"	N. H. Winchell. " 2562.
5984	"	"	Atactoporella occidentalis	1	Minneapolis, Minn	"	" " 2578.
5985	"	"	Atactoporella insueta, Ulrich	1	" "	"	C. L. Herrick. " 754.
5986	1872	"	Prasopora simulatrix, Ulrich	1	Pettit's Mill, Mantorville, Minn	Trenton (?)	N. H. Winchell. From 342.
5987	1882	"	Prasopora simulatrix	1	Sec. 16, Minneola, Goodhue Co., Minn	Trenton shales.	" " 4997.
5998	1877	"	Prasopora simulatrix	1	St. Paul, Minn	"	"
5989	1882	"	Prasopora contigua, Ulrich	1	Sec. 16, Minneola, Goodhue Co., Minn	"	" " 4997.
5990	Sept., 1880.	"	Prasopora insularis, Ulrich	1	Near Fountain, Minn	"	" " 4064.
5991	1882	"	Prasopora insularis	1	Sec 16, Minneola, Goodhue Co., Minn	"	" With (at a) Petigopora asperula, Ulrich. From 4997
5992	1872	"	Prasopora insularis	1	Pettit's Mill, Mantorville, Minn	Trenton (?)	" From 342.
5993	Sept., 1880.	"	Diplotrypa infida, Ulrich	1	Near Fountain, Minn	Trenton shales.	" " 4064.
5994	....	"	Aspidopora parasitica, Ulrich	1	Lanesboro, Minn	"	"
5995	1885	"	Aspidopora parasitica	1	Minneapolis, Minn	"	E. O. Ulrich.
5996	"	"	Amplexopora superba, Foord	1	" "	"	"
5997	1876-1879	"	Amplexopora superba	1	" "	"	C. L. Herrick. From 2123.
5998	Aug., 1877.	"	Amplexopora superba	1	St. Paul, Minn	"	N. H. Winchell. " 2578.
5999	"	"	Amplexopora winchelli, Ulrich	1	" "	"	" " 2578.

6000	1876-1879	"	Amplexopora winchelli	1	Minneapolis, Minn	"	C. L. Herrick. " 5123.
6001	1885	"	Amplexopora winchelli (?)	1	" "	"	E. O. Ulrich
6002	Oct., 1872.	"	Batostoma ottawaensis, Foord	1	Pettit's Mill, Mantorville, Minn	Trenton	N. H. Winchell. " 357.
6003	1885	"	Batostoma irrasa, Ulrich	1	Minneapolis, Minn	Trenton shales.	E. O. Ulrich.
6004	1882	"	Batostoma irrasa (?)	1	Minneola, Goodhue Co., Minn	"	N. H. Winchell. " 4996.
6005	"	"	Batostoma irrasa (?)	1	Minneola, Goodhue Co., Minn	"	" " 4996.
6006	1875	"	Batostoma fertilis, Ulrich	1	Minneapolis, Minn	"	" " 282.
6007	Nov., 1884.	Presented	Batostoma fertilis	1	Eyota, Minn	"	Presented by Miss Carrie S. Seymour. From 5581.
6008	1876-1889	Geol Survey.	Batostoma fertilis	1	Minneapolis, Minn	"	C. L. Herrick. From 5123.
6009	1879	"	Batostamella ramulosa, Ulrich	1	Oxford Mills, near Cannon Falls, Minn	"	N. H. Winchell. " 3486.
6010	1880	"	Trematopora primigenia, Ulrich	1	Near Fountain, Minn	"	" " 5529.
6011	1885	"	Trematopora primigenia	1	Minneapolis, Minn	"	E. O. Ulrich.
6012	1876-1879	"	Bythopora herricki, Ulrich	1	" "	"	C. L. Herrick. " 5121.
6013	....	"	Bythopora herricki	1	St. Paul, Minn	"	....
6014	....	Dr. Stoneman.	Callopora prematura, Ulrich	1	....	"	Records doubtful. From 79.
6015	....	Geol.Survey.	Callopora fraudulenta, Ulrich	1	Near Fountain, Minn	"	....
6016	Sept., 1880.	"	Dekayia trentonensis, Ulrich	1	" "	"	N. H. Winchell. From 4050.
6017	1885	"	Dekayia trentonensis	1	Minneapolis, Minn	"	E. O. Ulrich.
6018	Sept., 1880.	"	Dekayia internexa, Ulrich	1	Near Lanesboro, Minn	"	N. H. Winchell. " 4030.
6019	1876-1879	"	Dekayella contracta, Ulrich	1	Minneapolis, Minn	"	C. L. Herrick. " 5123.
6020	Sept., 1880.	"	Dekayella contracta	1	Near Lanesboro, Minn	"	N. H. Winchell. " 4036.
6021	1885	"	Dekayella contracta	1	Minneapolis, Minn	"	E. O. Ulrich.
6022	1873	"	Monotrypella multitabulata, Ulrich	1	Minneapolis Minn. (Finns Glen)	"	N. H. Winchell. " 330.
6023	Oct., 1875.	"	Monotrypella multitabulata	1	Fillmore, Fill. Co., Minn.	"	" " 259.
6024	1885	"	Leptotrypa indiffens, Ulrich	1	Minneapolis, Minn	"	E. O. Ulrich.
6025	"	Presented	Sporangites huronensis (?)	2	East Cleveland, O	Bedford shales.	From Rev. O. Hertzer.
6026	Aug., 1885.	Geol.Survey.	Ferruginous quartz schist	1	Black River Falls, Wis.	....	N. H Winchell. Dubuque mine. No. 2.
6027	"	"	" " "	1	" "	....	N. H. Winchell. York's opening, Mound No. 2, near the river.
6028	"	"	" " "	1	" "	....	N. H. Winchell. From the pit of Big Mound.
6029	"	"	" " "	1	" "	....	N. H. Winchell. Average surface specimen of the Big Mound.
6030	"	"	" " "	1	" "	....	N. H. Winchell. Summit of the Big Mound.
6031	"	"	" " "	1	" "	....	N. H. Winchell. Mound No. 5.
6032	"	"	" " "	1	" "	....	" Dubuque mine.
6033	"	"	Red quartzyte	1	" "	....	"
6034	"	"	Hematite	1	" "	....	" Drift No. 1.
6035	"	"	Potsdam shale	1	" "	....	" At the "Blue specular" drift.

Specimens registered in the General Museum in 1885.—Continued.

Serial Number.	OBTAINED. When.	OBTAINED. Whence.	NAME.	No. of Specimens.	Locality.	Formation.	Collector and Remarks.
6036	Aug., 1885.	Geol. Survey	Magnesian schist	1	Black River Falls, Wis.		N. H. Winchell.
6037	"	"	Grand Rapids plaster	1	Grand Rapids, Mich.		"
6038	Aug. 15, 1885	Presented	Chloritic red granite	Ind.	Sleepy Eye, Minn		Presented by C. M. Hunt. From a well 269 feet deep, (8 feet in this rock.
6039	Sept., 1885.	"	Refined rock salt	"	Marine City, Mich		From Marine City Stone Co.
6040	"	"	Calcareous tufa	1	S. Moccasin Mts., Mont.		" Rudolf Von Tabel, Jr.
6041	"	"	Orthis remnicha, Winch.	1	Red Wing, Minn.		From Dr. J. H Sandberg. In the street, 2 feet below the surface, in front of his office. Mostly the same level as No. 6042.
6043	"	"	Feldspar (after leucite)	2	Magnet Cove, Ark.		From J. F. Kunz.
6047	"	"	Schist	1	Near Falkenstein, Saxony		" C. L. Herrick.
6048	"	"	Slate	1	Near Altorf, north of St Gothard		" "
6071	"	Geol. Survey	"Deposited silica"	1	Belvidere, Goodhue Co., Minn	Madison	N. H. Winchell.
6072	Aug. 5, 1885	"	Drift sand. Orig. No. 1.	Indef	Minneapolis, Minn	Drillings from the deep well at the West hotel.	" 18 feet.
6073	"	"	Lime rock. Orig. No. 2.	"	" "		" 10 "
6074	"	"	Green shales. Orig. No. 3.	"	" "		" 10 "
6075	"	"	White sandrock. Orig. No. 4.	"	" "		" 91 "
6076	"	"	Yellow sandrock. Orig. No. 5.	"	" "		" 30 "
6077	"	"	Yellow sandrock. Orig. No. 6 and 7.	"	" "		" 5 "
6078	"	"	White sandrock. Orig. No. 8.	"	" "		" First flow of water, (Red shale 4 feet.) 10 feet.
6079	"	"	Yellow sandrock. Orig. No. 9.	"	" "		" 18 feet.
6080	"	"	Gray sandrock. Orig. No. 10.	"	" "		" 6 "
6081	"	"	Red quartzyte. Orig. No. 11.	"	" "		" effervesces feebly. 32 feet.
6082	"	"	Siliceous fine limestone. Orig. No. 12.	"	" "		" 40 feet.
6083	"	"	Red siliceous limestone. Orig. No. 13.	"	" "		" 10 "

6084	"	"	Limestone with white sand. . .Orig. No. 14.	"	" "	Drillings from the deep well at the West hotel.	" Similar to No. 12, but rather yellowish-pink. 15 feet.
6085	"	"	Calcareous quartzyte.........Orig. No. 15.	"	" "		" 6 feet.
6086	"	"	Fine, light pinkish limestone. . Orig. No. 16.	"	" "		" 30 "
6087	"	"	White sand ....Orig. No. 17.	"	" "		" Second flow of water. 5 feet.
6088	"	"	Fine pinkish sand, very hard. Orig. No. 18.	"	" "		" 1 foot.
6089	"	"	Rounded, coarse, white sand. . Orig. No. 19.	"	" "		" Water increased to No. 20. 90 feet.
6090	"	"	Calcareous shale.............Orig. No. 20.	"	" "		N. H. Winchell. 45 feet.
6091	"	"	Green shale.................Orig. No. 21.	"	" "		" 104 "
6092	"	"	Hard sub-crystalline shale....Orig. No. 22.	"	" "		" 12 "
6093	"	"	White sandrock..............Orig. No. 23.	"	" "		" Third flow of water. 30 feet.
6094	Oct., 1883.	By Exchange..	Bryozoa	"	Keokuk, Iowa..........	Keokuk.....	From A. S. Tiffany, Davenport, Ia
6095	"	"	Sperifera strigosus, Meek.........	3	Rockford, Iowa..........	Chemung......	" "
6096	"	"	Sperifera whitneyi, Hall.........	2	" "	"	" "
6097	"	"	Sperifera hungerfordi, Hall.........	2	" "	"	" "
6098	"	"	Sperifera	1	Buffalo, Iowa..........	Hamilton......	" "
6099	"	"	Orthis cyclus, Hall.........	2	Rock Island Ill..........	"	" "
6100	"	"	Orthis iowensis, Hall	3	" "	"	" "
6101	"	"	Orthis suborbicularis, Hall	1	" "	"	" "
6102	"	"	Orthis	2	Rock Island and Scott Co., Ia..........	"	" "
6103	"	"	Athyris spiriferoides, Eaton	3	18 mile creek, Erie Co., N. Y..........		" "
6104	"	"	Athyris vittata, Hall.........	4	Buffalo, Iowa..........	Hamilton......	" "
6105	"	"	Atrypa reticularis, Linn	4	Rockford, Iowa..........	Chemung......	" "
6106	"	"	Monticulipora	2	Buffalo, Iowa..........	Hamilton......	" "
6107	"	"	Productus longispinus, Law	1	Atkinson, Ill..........	Coal Meas......	" "
6108	"	"	Productella dissimilis, Hall.........	6	Rockford, Iowa..........	Chemung......	" "
6109	"	"	Strophonella reversa, Hall.........	5	" "	"	" "
6110	"	"	Pentamarella urata, Con.........	1	Buffalo, Iowa..........	Hamilton......	" "
6111	"	"	Strophodonta demissa, Con.........	2	Davenport, Iowa..........	"	" "
6112	Sept., 1885.	Geol.Survey....	Drillings. Rock, about 2 feet thick, black,	Indef	Browns Valley..........	....	From J. O. Barrett, at 360 feet.
6113	"	"	" Stratum of green colored......	"	" "	....	" " 450 "
6114	"	"	" Quick-sand..........	"	" "	....	" " 460 "
6115	"	"	" Rock below 75 feet..........	"	Mankato, Minn..........	....	" A. F. Beckdolt. Well on Third St. Depth of well 96 feet.
6116	"	Presented......	" Gray syenitic rock	"	Herman, Minn..........	....	From Chas. Pullman. At 150 ft.
6117	"	"	" Gray syenitic rock	"	" "	....	" " 152 "
6118	Oct., 1885.	Geol.Survey. .	Marly Clay	"	Albert Lea, Minn..........	....	" E. D. Edward. From 12-18 in. below the surface.
6119	"	"	Drift fragment, "Northern limestone".....	1	Washington Co., Minn...	Drift..........	N. H. Winchell.
6120	"	"	Ogishkie Muncie conglomerate	1	Marine Mills, Minn......	"	"
6121	Nov., 1885.	"	Hematite..........	1	Black River Falls, Minn.	....	"

Specimens registered in the General Museum in 1885.—Continued.

Serial Number.	OBTAINED. When.	OBTAINED. Whence.	NAME.	No. of Specimens.	Locality.	Formation.	Collector and Remarks
6122	Nov., 1885.	Geol Survey	Catlinite	2	Barron Co., Wis.		N. H. Winchell.
6123	Oct., 1885.	Presented	Cryptozoon proliferum	1	3 miles west of Saratoga Springs, N. Y.	Calciferous	From. C E. Hall. With a thin section of the same.
6124	"	"	Dioryte	2	Near Palisade, Dak.		From J. E. Todd.
6125	"	Geol. Survey	Drillings. Granite below 280 feet	Ind.	Milbank, Grant Co., Dak.		From J. W. Williams. 1st, 75 ft. blue clay; 2d, 200 ft. shale; 3d, 8 ft. gravel & shells; 4th, the granite.
6126	"	Presented	Hyolithellus micans, Billings	1	Columbia Co., N. Y.	L Potsdam	From S. W. Ford.
6127	"	"	" " and Fordilla troyensis, Barr	1	Columbia Co., N. Y., near Schodack Landing	"	" "
6128	"	"	Stenotheca rugosa, Hall	1	" " "	"	" "
6129	"	"	Microdiscus speciosus, Ford	1	Troy, N. Y.	"	" " Head and pygidia.
6130	"	"	" " and lobatus, Hall	1	Columbia Co., N. Y.	"	" " With embryo of Olenellus asaphoides.
6131	"	"	Graptolithus sagittarius, pristis and gracilis	5	Schodack Landing, N. Y. Rensselaer Co.	Lorraine shales	From S. W. Ford.
6132	"	"	" " bicornis and scalaris	3	" " "	"	" "
6133	"	"	" scalaris and bicornis	1	" " "	"	" "
6134	"	"	" furcatus and pristis	2	" " "	"	" "
6135	"	"	" pristis	1	" " "	"	" "
6136	"	"	Archimedes wortheni ?	6	Russelville, Ky	Carbon	From G. R. Lumsden, Greenville, Conn.
6137	"	"	Pentremites godonii, DeFrance	5	" "	"	" " "
6138	"	"	Pentamerus galeatus	5	" "	Up. Silurian	" " "
6139	"	"	Petraia corniculum	1	" "	Low. Silurian	" " "
6140	"	"	Chenopus pes-pelicana, Phill	1	Asti in Piedmont	Pliocene	" " "
6141	"	"	Trochus majus, Lamark	1	" "	"	" " "

6142	"	"	Cancellaria cancellata, Lam	1	" "	"	"	"	"
6143	"	"	Buccinium prismaticum, (Brug.)	1	Casteli arquanto, Parma.	Mushcelsand	"	"	"
6144	"	"	Pectunculus polydonta, Bronn	1	Flonheim, Rheinhessen	Miocene	"	"	"
6145	"	"	Corbula revoluta, Lam	2	Bordeaux	"	"	"	"
6146	"	"	Astarte omalii	2	Antwerpen	"	"	"	"
6147	"	"	Cyrena subarata, Brown	2	Alzey, Rheinhessen	"	"	"	"
6148	"	"	Cerythium margaritaceum, Broig	1	" "	"	"	"	"
6149	"	"	" cincium, Lam	2	" "	"	"	"	"
6150	"	"	" inconstans, B	5	Wien	"	"	"	"
6151	"	"	Fusus burdifakensii, Lam	1	Bordeaux	"	"	"	"
6152	"	"	Cyclostoma bisulcatum, Zeit	1	Hochheim, Mainz	"	"	"	"
6153	"	"	Lamna cuspidata, Agassiz	3	Flonheim, Rheinhessen	"	"	"	"
6154	"	"	Nummulites dufrenoy. d'Arch	10	Adelholzen		"	"	"
6155	"	"	Leda deshajesana, (d'Orb.)	1	Basele, Antwerpen	Eocene	"	"	"
6156	"	"	Cerithium cristatum, Lam	2	Rheims	"	"	"	"
6157	"	"	Turritella imbricata, Ley	2	Conizae		"	"	"
6158	"	"	Fusus bulbiformis, Det	1	Barton Cliff, Hampshire	Eocene	"	"	"
6159	"	"	Rostellaria	2	Paris	"	"	"	"
6160	"	"	Inoceramus sulcatus, Lam	2	Perte du Rhone		"	"	"
6161	"	"	Scyphia fuscata	1			"	"	"
6162	"	"	Terebratula sella, Sow	2	Sheppenstedtin, Braunsweig		"	"	"
6163	"	"	Cyrena heysii, D	1	Obernkirchen, Westphalen	Weald. Clas.	"	"	"
6164	"	"	Paludina fluviorum, Mantell	1	Osterwald	"	"	"	"
6165	"	"	Pentacrinus pentagonia. Gold	3	Streitberg, Bayern	Coral Crag	"	"	"
6166	"	"	Millericrinus horridus, d'Orb	1	Launoy, Dept. des Ardennes		"	"	"
6167	"	"	Ammonites hecticus	1	Gammelshausen, Wurtt.	Oxford Clay	"	"	"
6168	"	"	Terebratula perovalis, Sow	1	Aalen. Wurtenberg		"	"	"
6169	"	"	Terebratula numismalis, Sow	1	Rautenberg, Braunschweig	Mid. Lias	"	"	"
6170	"	"	Ammonites amaltheus, Sehl	2	Plateau deLarzae, France	Up. Lias	"	"	"
6171	"	"	Ammonites oxynodus, Am	1	Goeppingen, Wurtenberg.	L. Lias.	"	"	"
6172	"	"	Cidaris dorsata, Bronn	3	St. Cassian, Tyrol	Triassic	"	"	"
6173	"	"	Nucula frigillata, Golaf	1	" "	"	"	"	"
6174	"	"	Naticella cortata	1	" "	"	"	"	"
6175	"	"	Pleurotomaria radiata, Wi	5	" "	"	"	"	"
6176	"	"	Terebratula vulgaris, (Sehl)	2	Bayreuth		"	"	"
6177	"	"	Avicula socialis, Deshays	1	Erkerode, Braunschweig	Mid. Trias	"	"	"
6178	"	"	Trigonia vulgaris, (Sehl)	1	Bayreuth		"	"	"
6179	"	"	Avicula spelinaria	1	Altenstein, Thuringen	Mgn. limestone.	"	"	"
6180	"	"	Orthis mickclini, Ver.	1	Vise, Belgien	Mt. limestone	"	"	"
6181	"	"	Spirifer lineatus, Buch	3	" "	Carb. limestone	"	"	"
6182	"	"	Cyathophyllum caespetosum, Goldf	1	Refrath, Bensberg.	Dev. limestone.	"	"	"
6183	"	"	Terebratula primpelaris, Buch	1	Gerolstein, Eifel	"	"	"	"
6184	"	"	Atrypa reticularis, (d'Orb)	1	Renfrath, Coeln		"	"	"

Specimens registered in the General Museum in 1885.—Concluded.

Serial Number.	OBTAINED. When.	OBTAINED. Whence.	NAME.	No. of Specimens.	Locality.	Formation.	Collector and Remarks.
6185	Oct., 1885.	Presented	Orthis eipliensis	1	Gerolstein, Eifel	Dev. limestone.	From G. R. Lumsden, Greenville, Conn.
6186	"	"	Orthis resupinata, F. Roemer	1	" "	"	" " "
6187	"	"	Murchisonia bilineata (d'Arch)	2	Paffrath, Coeln	"	" " "
6188	"	"	Goniatites retrorsus, Buch	2	Budesheim, Eifel	Dev. shales	" " "
6189	"	"	Terebratula linguata, Buch	2	Carlshutte, Beraun		" " "
6190	"	"	Orthis elegantala, (Dalm)	1	Klinteham, Gottland		" " "

ARCHÆOLOGICAL SPECIMENS REGISTERED IN THE GENERAL MUSEUM IN 1885.

131. Stone implement found in digging the foundation of Hanover College, Jefferson county, Ind., on the Ohio river bluff. By purchase at the New Orleans industrial and cotton centennial exposition, from—Powers, 1885.

132. Stone implement from southern Indiana, near the Ohio river. By purchase from Powers, 1885.

133. Stone implement from southern Indiana, near the Ohio river. By purchase from Powers, 1885.

134. Stone implement from southern Indiana, near the Ohio river bluff. By purchase from Powers, 1885.

135. Stone implement from Austin, Scott county, Ind. By purchase from Powers, 1885.

136. Stone implement from southern Indiana, near the Ohio river. By purchase from Powers, 1885.

137. Stone implement from southern Indiana, near the Ohio river. By purchase from Powers, 1885.

138. Stone implement from southern Indiana, near the Ohio river. By purchase from Powers, 1885.

139. Stone implement from southern Indiana, near the Ohio river. By purchase from Powers, 1885.

140. Stone implement from Chickamauga creek, near the battle ground, Tenn. By purchase from Powers, 1885.

141. Stone pestle from southern Indiana, near the Ohio river. By purchase from Powers, 1885.

142. Stone pestle from southern Indiana, near the Ohio river. By purchase from Powers, 1885.

143. Stone pestle from southern Indiana, near the Ohio river. By purchase from Powers, 1885.

144. Stone implement from southern Indiana, near the Ohio river. By purchase from Powers, 1885.

145. Four stone axes from southern Indiana, near the Ohio river. By purchase from Powers, 1885.

146. Two stone disks dug from a mound in Charleston, Mo. Found with a skeleton. By purchase from Powers, 1885.

147. Chert implement dug from a mound at Charleston, Mo. By purchase from Powers, 1885.

148. Chert spear-head from Charleston, Mo. By purchase from Powers in 1885.

149. Stone disk from top of Lookout mountain, Ala. By purchase from Powers, 1885.

150. Stone disk from southern Indiana, near the Ohio river. By purchase from Powers, 1885.

151. Stone implements (three) from Doty's mill on Big creek, Jennings tp., Scott county, Ind. By purchase from Powers, 1885.

152. Chert spear-head. Near Lexington, Scott county, Ind. By purchase from Powers, 1885.

153. Large chert hoe. Mississippi river, Ballard county, Ky. By purchase from Powers, 1885.

154. Fourteen chert implements out of a nest of 23 pieces, all standing edgewise, plowed up on the farm of Hon. Wm. H. English, Lexington, Scott county, Ind. By purchase from Powers, 1885.

155. Three scrapers from southern Indiana, near the Ohio river. By purchase from Powers, 1885.

156. Three chert scrapers from southern Indiana, near the Ohio river. By purchase from Powers, 1885.

157. Two chert knives from southern Indiana, near the Ohio river. By purchase from Powers, 1885.

158. Fifteen chert arrow-heads from southern Indiana, near the Ohio river. By purchase from Powers, 1885.

159. Fourteen chert arrow-heads from southern Indiana, near the Ohio river. By purchase from Powers, 1885.

160. Fifteen chert arrow-heads from southern Indiana, near the Ohio river. By purchase from Powers, 1885.

161. Ten chert arrow-heads from southern Indiana, near the Ohio river. By purchase from Powers, 1885.

162. Eight chert arrow-heads from southern Indiana, near the Ohio river. By purchase from Powers, 1885.

163. Eight rough chert implements from southern Indiana, near the Ohio river. By purchase from Powers, 1885.

164. Twelve chert arrow-heads from southern Indiana, near the Ohio river. By purchase from Powers, 1885.

165. Two chert knives from southern Indiana, near the Ohio river. By purchase from Powers, 1885.

166. One chert knife from southern Indiana, near the Ohio river. By purchase from Powers, 1885.

167. One chert knife from southern Indiana, near the Ohio river. By purchase from Powers, 1885.

168. Five chert knives from southern Indiana, near the Ohio river. By purchase from Powers, 1885.

169. Chert implement from southern Indiana, near the Ohio river. By purchase from Powers, 1885.

170. Eight chert chisels from southern Indiana, near the Ohio river. By purchase from Powers, 1885.

171. Eight chert drills from southern Indiana, near the Ohio river. By purchase from Powers, 1885.

172. Fourteen chert arrow-heads from southern Indiana, near the Ohio river. By purchase from Powers, 1885.

173. Eleven chert knives from southern Indiana, near the Ohio river. By purchase from Powers, 1885.

174. Eight chert arrow-heads from southern Indiana, near the Ohio river. By purchase from Powers, 1885.

175. Four chert knives from southern Indiana, near the Ohio river. By purchase from Powers, 1885.

176. Nine chert arrow-heads from southern Indiana, near the Ohio river. By purchase from Powers, 1885.

177. Eleven chert knives from southern Indiana, near the Ohio river. By purchase from Powers, 1885.

178. Two chert implements from southern Indiana, near the Ohio river. By purchase from Powers, 1885.

179. Eight chert implements from southern Indiana, near the Ohio river. By purchase from Powers, 1885.

180. Catlinite goblet. Pipestone City, Minn. By purchase, 1885.

181. Catlinite goblet. Pipestone City, Minn. By purchase, 1885.

182. Catlinite paper-weight. Pipestone City, Minn. By purchase, 1885.

183. Catlinite pipe, with spear-head bowl and wooden stem. Pipestone City, Minn. By purchase, 1885.

184. Catlinite pipe, with "dog's-head bowl" and wooden stem. Pipestone City, Minn. By purchase, 1885.

185. Catlinite pipe, with "horse-head" bowl and wooden stem. Pipestone City, Minn. By purchase, 1885.

186. Catlinite pipe, with tomahawk bowl and stone stem. Pipestone City, Minn. By purchase, 1885.

187. Catlinite pipe, with hand holding the bowl and wooden stem. Pipestone City, Minn. By purchase, 1885.

188. Catlinite pipe, with tomahawk head. Pipestone City, Minn. By purchase, 1885.

189. Catlinite pipe. Pipestone City, Minn. By purchase, 1885.

190. Catlinite pipe, with tomahawk bowl and stone handle, (all one piece.) Pipestone City, Minn. By purchase, 1885.

191. Old pipe, plowed up at St. Paul, Minn.

192. Fragments (three) of Indian pottery. From mounds at the mouth of Cannon river, on land of C. Spates, sec. 22, Burnside, Goodhue county, Minn. Collected by N. H. Winchell.

193. Fragments (seven) of skulls from mounds at the mouth of Cannon river, on land of C. Spates, sec. 22, Burnside, Goodhue county, Minn. Collected by N. H. Winchell.

194. Implements of bone from mounds at the mouth of Cannon river, on land of C. Spates, sec. 22, Burnside, Goodhue county, Minn. Collected by N. H. Winchell.

195. Implements of bone from mounds at the mouth of Cannon river, on land of C. Spates, sec. 22, Burnside, Goodhue county, Minn. Collected by N. H. Winchell.

196. One knife, highly finished, of granular quartzyte, 9 inches long by 2½, from mounds at the mouth of Cannon river, on land of C. Spates, sec. 22, Burnside, Goodhue county, Minn. Collected by N. H. Winchell.

197. Stone implement from mounds at the mouth of Cannon river, on land of C. Spates, sec. 22, Burnside, Goodhue county, Minn. Collected by N. H. Winchell.

198. Unfinished stone pipe from mounds at the mouth of

Cannon river, on land of C. Spates, sec. 22, Burnside, Goodhue county, Minn. Collected by N. H. Winchell.

Besides the foregoing, the collections of Dr. H. E. Twitchell have been deposited in the museum, to remain at least four years. These will finally be presented to the museum by Dr. Twitchell, according to his present design. They comprise several hundred specimens, characteristic of the mound-builders of Indiana and Ohio.

ZOOLOGICAL

Catalogue number.	Original number.	NAME.	Sex.	Locality.	Nature of specimen.
918	...	Geomys bursarius, (Shaw) Rich.	...	Hennepin Co., Minn.	M't'd
919	....	Sula bassania, (Linn.) Bris.	....	Florida	"
920	....	Nest and egg of Hummer	....	California	
921	....	Nest of Hummer	....	"	
922	....	Nest of Flycatcher	....	"	
923	....	Nest of Titmouse	....	"	
924	....	Loligo pealii, LeS. (Dissection)	....	Salem, Mass.	Alcohol
926	....	Salmo namaycush, Block	....	Grand Marais	"
927	....	Stizostelhium vitreum	....	"	"
928	....	Vertebra of a whale	....	Salem Harbor, Mass.	Dry
929	....	Acipenser rubicundus LeS	F.	Minneapolis	M't'd
931	....	Ovis montana, Cuv ... Head.	M.	Near Ft. Benton, Mon.	Dry
932	....	Rangifer caribou, Aud. & Bach ... Head.	....	Near Grand Marais.	"
933	....	Process of vertebra of whale	....	Bakers Isl'd, Salem, Mass	"
934	....	Lingula anatina	....	Higo, Japan	Alcohol
935	....	Pityophis melanoleucus, Holb.	....	Ramsey Co., Minn	"
936	....	Sceloporus undulatus, Harlan	....	Sherwood, Tennessee	"
937	....	Eutænia	F.	Minneapolis.	"
938	....	Amblystoma punctatum (L.) Baird	....	"	"
939	....	" "	...	"	"
940	....	Ostrea borealis, 1 day old	....	Rowes Oyster Farm, L.I.S	Dried
941	....	" " 2 weeks old	....	" " "	"
942	....	" " 2 years old	....	Ludington's beds, New Haven, Conn.	"
943	....	" " 2 years, 4 months old	....	H. C. Rowes Farm, L.I.S.	"
944	....	" " 3 years old	....	" " "	"
945	....	" " 4 " "	....	" " "	"
946	....	" " 5 " "	....	Ludington's beds, New Haven, Conn	"
947	....	" " 7 " "	....	" " "	"
948	....	" " 17 " "	....	Natural bed Indian Neck, Conn	"
949	....	" " 25 " "	....	" " "	"
950	....	Lepas Hillia	....	Turks Island	Alcohol
951	....	Pyrula carica (Winkle Shell)	....	Long Island Sound	Dry
952	....	Pyrula canaliculata (Spawn of Winkle)	....	New Haven, Conn.	"
953	....	Crepidula	....	" "	"
954	....	Gorgonia	....	Hampton, Va., Johns Hopkins, Biol. Lab.	Alcohol
955	....	Balanoglossus	....	" " "	"
956	....	"	....	" " "	"
957	....	Amphioxus lanceolatus	....	" " "	Corr. Sublimate.
958	....	" "	....	" " "	Alcohol
959	....	" "	....	" " "	Picric Acid.
960	....	" "	....	" " "	Chromic Acid
961	3	Fiber zibethicus, (L.) Cuv.	....	Minneapolis	M't'd
962	18	Geomys bursarius, (Shaw) Rich.	M.	"	"
963	19	" "	F.	"	"
964	27	Condylura cristata, (L.) Desm.	....	Hinckley, Minn.	"
965	28	Putonius ermineus, Cuv	....	" "	"
966	36a	Sciuropterus volucella	....	Monticello, Minn	"
967	36b	" "	....	" "	"
968	9	Tamias striatus, (L.) Baird	....	Hinckley, Minn.	"
969	8	Sciurus hudsonius, Pallas	....	Pine City, Minn.	"
970	6	" carolinensis, Auct.	....	Minneapolis	"
971	33	Tamias striatus, (L.) Baird	....	Hinckley, Minn.	"
972	....	Picoides arcticus, (Swains) Gray	M.	"	"
973	....	" "	M.	"	"

REGISTER.

Collected by	When collected.	OBTAINED. When.	OBTAINED. Whence.	No. of specimens.	Remarks.
E. Lyman Hood ...	May 28, 1881.	May, 1881.	E. Lyman Hood ...	1	Presented.
....	....	"	Regent Chute	1	"
E. L. Huggins	....	March, 1881	E. L. Huggins.....	1	"
"	....	"	"	1	"
....	....	"	"	1	"
....	....	"	"	1	"
C. W. Hall.........	1880	1880	C. W. Hall.........	1	....
"	August, 1881.	1881	"	2	....
"	"	"	"	1	....
"	August, 1880.	"	"	.....	....
M. Pettingill.......	July, 1880.	"	M. Pettingill.......	.....	Presented.
S F. Peckham.....	1880	"	C. W. Hall.........	1	Depos'td by C.W.H
Mayhew Bros......	"	"	Mayhew Bros......	1	....
C W. Hall.........	"	"	C. W. Hall.	2	....
Prof. E. S. Morse ..	1879	1880	Prof. E. S Morse..	1	Presented.
Thos. S Roberts...	1882	1882	Thos. S. Roberts...	1	"
N. H. Winchell....	1881	1881	N. H. Winchell....	1	"
N. M. Baker.......	1882	1882	N. M. Baker	1	" Dissected to show viscera.
R. M. Bell	"	"	R. M. Bell	1	Presented. Dissected to show nervous system.
"	"	"	"	1	Presented. Dissected to show viscera
H. C. Hovey.......	1883	1883	H. C. Hovey	Indef.	
"	"	"	"	"	
"	"	"	"	3	
"	"	"	"	7	
"	"	"	"	5	Presented after the Minneapolis meeting, A. A. A. S.
"	"	"	"	1	
"	"	"	"	1	
"	"	"	"	2	
"	"	"	"	1	
"	"	"	"	1	
Geo. W. Mansfield.	1882	1882	Geo. W. Mansfield.	Indef.	Presented.
H. C. Hovey.......	1883	1883	H. C. Hovey	2	"
"	"	"	"	2	"
"	"	"	"	1	"
H. F. Nachtrieb...	"	"	H. F. Nachtrieb...	1	"
" ...	"	"	"	Indef.	"
" ...	"	"	"	"	"
" ...	"	"	"	Sev'rl	"
" ...	"	"	"	"	"
" ...	"	"	"	"	"
" ...	"	"	"	"	"
C. L. Herrick......	October, 1883.	Oct., 1883.	Geol. & N. H. Sur.	1	....
"	Nov., 1883.	Nov., 1883.	" "	.....	....
"	"	"	" "	.....	....
"	"	"	" "	.....	....
"	"	"	" "	.....	....
"	Dec., 1883.	Dec., 1883.	" "	.....	....
"	"	"	" "	.....	....
"	Nov., 1883.	Nov., 1883.	" "	.....	....
"	"	"	" "	.....	....
"	Oct., 1883.	Oct., 1883.	" "	.....	....
"	Nov., 1883.	Nov., 1883.	" "	.....	....
"	"	"	" "	1	....
"	"	"	" "	1	....

Zoological

Catalogue number.	Original number.	NAME.	Sex.	Locality.	Nature of specimen
974	....	Picoides arcticus	F.	Hinckley, Minn	M't'd ....
975	....	" "	F.	"	"
976	....	Hesperiphona vespertina, (Cooper) Baird..	M.	Minneapolis.	"
977	....	" "	F.	"	"
978	41	Lynx rufus, (Gold.) Raf....................	M.	....	....
979	34	" "	F.	Hinckley, Minn..........	M't'd ....
980	43	" " Young.........................	....	"	....
981	....	Lanius ludovicianus excubitorides, (Sw.) Coues.....................................	F.	....	M't'd ....
982	305	Carpodacus purpureus, (Gm.) Bd..........	M.	Minneapolis.	"
983	404	Xanthocephalus icterocephalus, (Bp.) Bd..	F	....	"
984	117	Ceryle alcyon, (L.) Boie....................	F.	Minneapolis.	"
985	232	Ampelis garrulus, Linn	....	Richfield, Minn..........	"
986	122	Geothlypsis trichas, (L.) Caban............	M.	Minneapolis..............	"
987	261	Harporhynchus rufus, (L.) Caban	F.	"	"
988	434	Cyanocitta cristata, (L.) Strickl...........	....	....	"
989	326	Centrophanes lapponicus...................	F.	Sandy Lake	"
990	414	Icterus spurius (L.) Bp.....................	M.	....	"
991	76	Picus pubescens, Linn.......	F.	Minneapolis.	"
992	349	Zonotricha albicollis, (Gm.) Bp	M.	"	"
993	158	Sialia sialis, (L.) Haldem..................	M.	"	"
994	217	Setophaga ruticilla, (L) Sw...	M.	Bet. Minneapolis & St. P.	"
995	391	Pipilo erythropthalmus, (L.) Vieill........	M.	Sandy Lake, Hennepin Co	"
996	112	Caprimulgus vociferus, Wils...............	M.	Minneapolis..............	"
997	213	Myiodioctes pusillus, (Wils.) Bp..........	M.	"	"
998	319	Loxia leucoptera. Gm................	M.	"	"
999	302	Eremophila alpestris, (Frost) Boie.........	F.	Sandy Lake, Anoka Co..	"
1000	302	" " Young	F.	" " "	"
1001	302	" " "	M.	" " "	"
1002	559	Fulica americana, Gmel.....................	....	Medicine Lake, Henn. Co	"
1003	194	Dendrœca coronata, (L.) Gray............	M.	Minneapolis	"
1004	61	Nyctea scandiaca, (L.) Newt.......... ...	M.	Windom, Cottonwood Co	"
1005	48	Bubo virginianus, (Gm.) Bp................	M.	Near Osseo, Hennepin Co	"
1006	233	Ampelis cedrorum (Vieill) Bd.............	....	Minneapolis.............	"
1007	254	Galeoscoptes carolinensis, (L.) Caban	M.	"	"
1008	504	Oxyechus vociferus, (L.) Reich............	M.	Sandy Lake, Anoka Co..	"
1009	400	Molothrus ater, (Bodd.) Gray..............	M.	" " "	"
1010	400	" "	F.	" " "	"
1011	317	Chrysomitris pinus, (Wils.) Bp	F.	....	"
1012	400	Molothrus ater, (Bodd.) Gray.............	....	Minneapolis	"
1013	39	Aquila chrysætus canadensis. (L.) Ridgw.	M.	Winnipeg, Manitoba.....	"
1014	39	" " "	F.	" "	"
1015	39	" " "	M.	" "	"
1016	39	" " "	F.	St. Croix River..........	"
1017	43	Haliætus leucocephalus, (L.) Savig........	M.	Howard Lake, Wright Co	"
1018	43	" "	F.	Monticello	"
1019	43	" " Young	....	Manitoba................	"
1020	44	Pandion haliætus carolinensis (Gm.) Ridgw.	....	....	"
1021	14	Astur atricapillus, Linn....................	M.	Near Medicine Lake, Hennepin Co..... ...	"
1022	14	" "	F.	Medicine Lake, Henn. Co	"
1023	14	" "	F.	On Watertown Road.....	"
1024	14	" "	M.	Moore Lake, Anoka Co..	"
1025	38	Circus hudsonius, (L.) Vieill..............	M.	Bet. Minneapolis & St. P.	"
1026	38	" " " " Young.....	M.	Near Medicine Lake, Hennepin Co..........	"
1027	38	" "	F.	St. Paul.................	"
1028	....	Aesalon columbarius (L.) Kaup	....	....	"
1029	13	Tinnunculus sparverius, (L.) Vieill.......	F.	Near Sandy, Anoka Co ..	"
1030	....	" "	....	....	"
1031	23	Buteo borealis, (Gm.) Vieill...............	M.	Minneapolis	"
1032	....	" "	....	....	"
1033	48	Bubo virginianus, (Gm.) Bp...............	M.	Bet. Minneapolis & St. P.	"
1034	48	" "	F.	Rockford, Wright Co....	"
1035	61	Nyctea scandiaca, (L.) Newt., Young......	M.	Windom, Cottonwood Co	"

Register.—Continued.

Collected by	When collected.	OBTAINED.		No. of specimens.	Remarks.
		When.	Whence.		
C. L. Herrick......	Nov., 1883.	Nov., 1883.	Geol. & N. H. Sur.	1	....
"	"	"	" "	1	....
"	Jan., 1883 (?)	Jan., 1883(?)	" "	1	....
"	Oct., 1883.	Oct., 1883.	" "	1	....
N. H. Winchell....	Nov., 1883.	Nov., 1883.	" "	[illegible]	....
C. L. Herrick......	"	"	" "	1	....
"	Feb., 1883.	Feb., 1883.	" "	1	....
Wm. Howling	....	1884	Wm. Howling	1	By purchase.
"	1879	"	"	4	"
"	....	"	"	1	"
"	July 20, 1880.	"	"	1	"
"	Dec. 12, 1881.	"	"	4	"
"	July 1, 1879.	"	"	1	"
"	1879	"	"	1	"
"	....	"	"	1	"
"	June, 1879.	"	"	1	"
"	....	"	"	2	"
"	1880	"	"	1	"
"	June 1, 1882.	"	"	1	"
"	July 27, 1881.	"	"	1	"
"	June 26, 1882.	"	"	1	"
"	1880	"	" ...	2	"
"	July 17, 1880.	"	"	1	"
"	June 13, 1880.	"	"	1	"
"	1880	"	"	2	"
"	July 21, 1881.	"	"	1	"
"	"	"	" ...	1	"
"	"	"	"	1	"
"	June 13, 1882.	"	"	1	"
"	May 13, 1881.	"	"	1	"
"	Dec. 20, 1880.	"	"	1	"
"	1884	"	"	1	"
"	....	"	"	1	"
"	1882	"	"	1	"
"	June 20, 1879.	"	"	1	"
"	July 31, 1883.	"	" ...	1	"
"	"	"	"	1	"
"	....	"	"	1	"
"	....	"	"	1	"
"	April 9, 1883.	"	"	1	"
"	"	"	"	1	"
"	"	"	"	1	"
"	1875	"	"	1	"
"	June 5, 1882.	"	"	1	"
"	April 21, 1884.	"	"	1	"
"	April 9, 1883.	"	"	1	"
"	....	"	"	1	"
"	1883	"	"	1	"
"	1881	"	"	1	"
"	1883	"	"	1	"
"	May 30, 1882.	"	" ...	1	"
"	October, 1883.	"	"	1	"
"	August, 1882.	"	"	1	"
"	1879	"	"	1	"
....	....	....	....	1	....
Wm. Howling.....	May, 1879.	1884	Wm. Howling.....	1	By purchase.
....	....	....	....	1	....
Wm. Howling.....	June 30, 1875.	1884	Wm. Howling.....	1	By purchase.
....	....	....	....	1	....
Wm. Howling	1883	1884	Wm. Howling.....	1	By purchase.
"	1882	"	"	1	"
"	June 31, 1881.	"	"	1	"

Zoological

Catalogue number.	Original number.	NAME.	Sex.	Locality.	Nature of specimen.
1036	61	Nyctea scandiaca	F.	Moose lake, Anoka Co	M't'd
1037	54	Strix debulosa, Forst	M.		"
1038	51	Asio americanus. (Steph) Sharpe	M.	Nr. Silver L, Ramsey Co.	"
1039	52	Asio accipitrinus, (Pall.) Newt	M.	Bet. Minneapolis & St P.	"
1040	52	" "	F.	Near Sandy L, Anoka Co	"
1041	52	" "	M.		"
1042	....	Haliaetus leucocephalus, (L) Savig	....		"
1043	....	" "	....		"
1044	....	Buteo borealis, (Gm.) Vieill	....		"
1045	....	Astur atricapillus, (Wils) Bp	....		"
1046	14	" " young.	M.	Anoka, Anoka Co	"
1047	27	Buteo pennsylvanicus (Wils.) Bp	M.	Wright Co.	"
1048	1	Cathartes aura (L.) Illig	M.	Lake Minnetonka	"
1049	49	Scops asio, (L.) Bp	M.	Coon Creek, Anoka Co	"
1050	49	" "	F.	Nr.L.Calhoun, Anoka Co	"
1051	47	Aluco flammeus americanus, (Aud.)Ridgw	M.		"
1052	112	Caprimulgus vociferus, Wils	F.	Near Sandy L, Anoka Co.	"
1053	112	" " "	M.	" " "	"
1054	114	Chordeiles popetue, (Vieill) Bd	M.	Minneapolis	"
1055	114	" "	F.	"	"
1056	94	Melanerpes erythrocephalus, (L.) Sw	M.	"	"
1057	97	Colaptes auratus, (L.) Sw	F.	"	"
1058	90	Hylotomus pileatus. (L.) Bd	M.	Wright Co	"
1059	90	" "	M.	"	"
1060	90	" "	F.	Maple Grove, Henn. Co.	"
1061	74	Picus villosus, Linn	M.	Minneapolis.	"
1062	85	Sphyrapicus varius, (L.) Bd	M.	"	"
1063	85	" "	F.	"	"
1064	59	Speotyto cunicularia hypogæa,(Bd.)Ridgw	M.	Dakota	"
1065	70	Coccygus erythropthalmus, (Wils) Bd	F.	Near Minneapolis	"
1066	70	" "	F.	"	"
1067	434	Cyanocitta cristata, (L.) Strickl	F.	"	"
1068	434	" "	M.	Minneapolis	"
1069	117	Ceryle alcyon, (L.) Boie	M.	Near Minneapolis	"
1070	117	" "	F.	L. Johannah, Ramsey Co	"
1071	399	Dolichonyx oryzivorus, (L.) Sw	M.	Rice creek, Anoka Co	"
1072	426	Corvus frugivorus, Bartr	M.	Medicine L., Henn. Co	"
1073	414	Icterus spurius. (L) Bp., young.	M.	Minneapolis	"
1074	414	" "	M.	"	"
1075	414	" "	F.	"	"
1076	414	" "	M.	"	"
1077	415	" galbula, (L.) Coues	M.	"	"
1078	401	Agelaeus phoeniceus, (L.) Vieill	M.	Near Sandy L. Anoka Co.	"
1079	404	Xanthocephalus icterocephalus, (Bp.) Bd	M.	Sandy lake, Anoka Co	"
1080	404	" " " "	F.	" "	"
1081	....	Quiscalus purpureus æneus, Ridgw	M.	Minneapolis	"
1082	406	Sturnella magna (L) Sw	M	Near Sandy Lk, Henn Co	"
1083	406	" "	F.	" " "	"
1084	417	Scolecophagus ferrugineus. (Gm) Sw	M.	" " "	"
1085	401	Agelæus phœniceus, (L.) Vieill	F.	" " "	"
1086	261	Harporhynchus rufus, (L.) Caban	F.	Minneapolis	"
1087	158	Sialia sialis, (L.) Haldem	F	"	"
1088	158	" "	M.	"	"
1089	155	Merula migratoria, (L.) Sw. & Rich	....	"	"
1090	155	" "	....	"	"
1091	232	Ampelis garrulus, Linn	M.	Richfield, Hennepin Co.	"
1092	232	" "	F.	" "	"
1093	233	" cedrorum. (Viell) Bd	M.	Minneapolis.	"
1094	233	" "	F.	"	"
1095	233	" " Young	M.	"	"
1096	233	" "	M.	"	"
1097	227	Tachycineata bicolor, (Vieill) Caban	M.	L'k Johannah Ramsey Co	"
1098	227	" "	F.	" "	"
1099	318	Loxia curvirostra americana. (Wils.)Coues	F.	Duluth	"
1100	318	" " "	M.	"	"

Register.—Continued.

Collected by.	When collected.	OBTAINED.		No. of specimens.	Remarks.
		When.	Whence.		
Wm. Howling	Oct. 23, 1881.	1884	Wm. Howling	1	By purchase.
"	Jan. 8, 1880.	"	"	1	"
"	1878	"	"	1	"
"	1882	"	"	1	"
"	1881	"	" ...	1	"
"	1879	"	"	1	"
....	....	....	N. L. Bailey.......	1	Presented.
....	....	....	"	1	"
....	....	....	....	1	Young.
....	....	....	....	1	....
Wm. Howling	1882	1884	Wm. Howling.....	1	By purchase.
"	"	"	"	1	"
"	1877	"	"	1	"
"	1882	"	"	1	"
"	"	"	"	1	"
"	....	"	"	1	"
"	Aug. 3, 1882.	"	"	1	"
"	"	"	"	1	"
"	Sept. 3, 1882.	"	" ...	1	"
"	July 30, 1883.	"	"	1	"
"	July, 1882.	"	"	1	"
"	July 27, 1881.	"	"	1	"
"	Feb. 20, 1880.	"	"	1	"
"	"	"	"	1	"
"	May 12, 1881.	"	"	1	"
"	1880	"	"	1	"
"	June 1, 1881.	"	"	1	"
"	"	"	"	1	"
"	1876	"	"	1	"
"	July, 1881.	"	" ...	1	"
"	July, 1879.	"	"	1	"
"	June, 1883.	"	"	1	"
"	"	"	"	1	"
"	July 20, 1880.	"	"	1	"
"	Aug. 1, 1882.	"	"	2	"
"	1882	"	"	1	"
"	August, 1878.	"	"	3	"
"	Summer of '80	"	"	4	"
"	"	"	"	1	"
"	"	"	"	1	"
"	"	"	"	2	"
"	July, 1881.	"	"	1	"
"	1881	"	"	3	"
"	June, 1881.	"	"	1	"
"	"	"	"	1	"
"	June 1, 1879.	"	"	1	"
"	May 15, 1879.	"	"	1	"
"	"	"	"	1	"
"	1879	"	"	1	"
"	"	"	"	1	"
"	....	"	"	1	"
"	June 1, 1882.	"	"	1	"
" ...	June 15, 1882	"	"	1	"
"	....	"	"	1	"
"	....	"	"	2	"
"	Dec. 12, 1881.	"	"	2	"
"	"	"	"	2	"
"	1880	"	"	1	"
"	July, 1880.	"	"	1	"
"	"	"	"	1	"
"	1879	"	"	2	"
"	May 4, 1882.	"	"	1	"
"	"	"	"	1	"
"	1877	"	" ...	1	"
"	"	"	"	1	"

Zoological

Catalogue number.	Original number.	NAME.	Sex.	Locality.	Nature of specimen.
1101	319	Loxia leucoptera, Gm	M.	Minneapolis	M't'd
1102	319	" "	F.	"	"
1103	220	Pyranga rubra, (L.) Vieill	M.	"	"
1104	220	" "	F.	"	"
1105	220	" "	M.	"	"
1106	220	" " (L.) Vieill	F.	"	"
1107	380	Zamelodia ludoviciana, (L) Coues	M.	Sandy lake, Anoka Co	"
1108	380	" "	F.	" "	"
1109	303	Hesperiphona vespertina, (Cooper) Bp	M.	Minneapolis	"
1110	303	" "	F.	"	"
1111	303	" "	M.	"	"
1112	303	" "	F.	"	"
1113	304	Pinicola enucleator, (L.) Vieill.	F.	"	"
1114	304	" "	M.	"	"
1115	304	" "	F.	"	"
1116	304	" " young.	M.	"	"
1117	391	Pipilo erythrophthalmus, (L.) Vieill	M.	Sandy lake, Anoka Co	"
1118	391	" "	M.	" "	"
1119	354	Junco hyemalis, (L.) Scl	....	Minneapolis	"
1120	325	Plectrophanes nivalis (L.) Meyer	M.	Osseo, Hennepin Co	"
1121	325	" "	M.	" "	"
1122	305	Carpodacus purpureus, (Gm.) Bd	M.	Minneapolis	"
1123	305	" "	M.	"	"
1124	326	Centrophanes lapponicus, (L.) Caban	M.	Sandy lake, Hennepin Co	"
1125	320	Aegiothus linaria, (L.) Caban	M.	Minneapolis	"
1126	313	Astragalinus tristis, (L.) Caban	M.	"	"
1127	313	" "	F	"	"
1128	349	Zonotrichia albicollis, (Gm.) Bp	M.	"	"
1129	238	Lanius ludovicianus excubitorides, (Sw.) Coues	M.	Anoka, Anoka Co	"
1130	279	Sitta canadensis, Linn	M.	Minneapolis	"
1131	277	Sitta carolinensis, Gmel	M.	"	"
1132	277	" " "	F.	"	"
1133	374	Passerella iliaca, (Merrem) Sw	....	Bet. Minneapolis & St. P.	"
1134	374	" "	....	" " "	"
1135	289	Parus atricapillus, Linn	....	Minneapolis	"
1136	289	" "	....	"	"
1137	130	Myiarchus crinitus, (L.) Caban	M.	Bet. Minneapolis & St. P.	"
1138	130	" "	F.	" " "	"
1139	130	" "	M.	" " "	"
1140	130	" "	F.	" " "	"
1141	348	Zonotrichia querula, (Nutt.) Gamb	M.	....	"
1142	345	" leucophrys, (Forst.) Sw	M.	Minneapolis	"
1143	275	Certhia familiaris rufa, (Bartr.) Ridgw	M.	"	"
1144	200	Dendrœca pennsylvanica, (L) Bd	M.	"	"
1145	200	" "	M.	"	"
1146	200	" "	M.	"	"
1147	194	" coronata, (L.) Gray	M.	"	"
1148	194	" "	F.	"	"
1149	101	Trochilus colubris, Linn	F.	"	"
1150	196	Dendrœca blackburniæ, (Gm.) Bd	M.	"	"
1151	181	Helminthophaga chrysoptera, (L.) Bd	F.	"	"
1152	181	" "	M.	"	"
1153	161	Regulus calendula, (L.) Licht	M.	"	"
1154	162	Regulus satrapa, Licht	F.	"	"
1155	162	" "	M.	"	"
1156	217	Setophaga ruticilla, (L.) Sw	F.	Bet. Minneapolis & St. P.	"
1157	217	" "	M.	" " "	"
1158	217	" "	F.	" " "	"
1159	217	" "	M.	" " "	"
1160	....	" "	M.	....	"
1161	....	" "	M.	....	"
1162	170	Geothlypsis trichas, (L.) Caban	M.	Sandy lake, Anoka Co	"
1163	206	Perissoglossa tigrina, (Gm.) Bd	....	" "	"
1164	206	" "	....	" "	"

Register.—Continued.

Collected by.	When Collected.	OBTAINED.		No. of specimens.	Remarks.
		When.	Whence.		
Wm. Howling	1880	1884	Wm. Howling	1	By purchase.
"	"	"	"	1	"
"	July 14, 1883.	"	"	1	"
"	"	"	"	1	"
"	1880	"	"	1	"
"	"	"	"	1	"
"	July 4, 1880.	"	"	1	"
"	"	"	"	1	"
"	1880	"	"	1	"
"	"	"	"	1	"
"	"	"	"	1	"
"	"	"	"	1	"
"	Dec., 1879.	"	"	1	"
"	Dec., 1878.	"	"	3	"
"	Dec., 1879.	"	"	1	"
"	"	"	"	1	"
"	1880	"	"	1	"
"	"	"	"	1	"
"	Nov., 1880.	"	"	1	"
"	Dec. 25, 1881.	"	"	1	"
"	"	"	"	1	"
"	1879	"	"	1	"
"	"	"	"	1	"
"	June, 1879.	"	"	2	"
"	1879	"	"	1	"
"	1881	"	"	1	"
"	"	"	"	1	"
"	May 28, 1879.	"	"	1	"
			"	1	"
"	Aug. 20, 1879.	"			
"	1880	"	"	1	"
"	"	"	"	1	"
"	"	"	"	1	"
"	June 17, 1880.	"	"	1	"
"	....	"	"	1	"
"	1880	"	"	1	"
"	"	"	"	1	"
"	June 16, 1882.	"	"	1	"
"	June 30, 1882.	"	"	1	"
"	June 16, 1882.	"	"	1	"
"	June 30, 1882.	"	"	1	"
....	....	....	....	1	....
Wm. Howling	1879	1884	Wm. Howling.....	1	By purchase.
"	"	"	"	1	"
"	May 30, 1882	"	"	1	"
"	June 2, 1879.	"	"	1	"
"	....	"	"	1	"
"	June, 1882.	"	"	1	"
"	May 13, 1881.	"	"	1	"
"	June 3, 1882.	"	"	1	"
"	June 7, 1882.	"	"	1	"
"	June 3, 1882.	"	"	1	"
"	"	"	"	1	"
"	May 23, 1880.	"	"	1	"
"	June 14, 1884.	"	"	1	"
"	June 1, 1880.	"	"	1	"
"	May 28, 1879.	"	"	1	"
"	June 26, 1882.	"	"	1	"
"	May 28, 1879.	"	"	1	"
....	June 26, 1882	"	"	1	"
....	....	....	....	1	"
....	....	....	....	1	"
Wm. Howling	June 30, 1882.	1884	Wm. Howling	1	"
"	May 29, 1879.	"	"	1	"
"	"	"	"	1	"

Zoological

Catalogue number.	Original number.	NAME.	Sex.	Locality.	Nature of specimen
1165	206	Perissoglossa tigrina	....	Sandy lake Anoka Co.	M't'd ....
1166	206	" "	....	" "	"
1167	204	Dendrœca maculosa, (Gm.) Bd	M.	Bet. Minneapolis & St. P.	"
1168	168	Parula americana, (L.) Bp	M.	Minneapolis	"
1169	168	" "	M.	"	"
1170	168	" "	F.	"	"
1171	202	Dendrœca striata, (Forst.) Bd	F.	Bet. Minneapolis & St. P.	"
1172	202	" "	M.	" " "	"
1173	203	" æstiva, (Gm.) Bd	M.	Rice creek, Anoka Co.	"
1174	183	Helminthophaga ruficapilla, (Wils.) Bd	....		"
1175	183	" "	....		"
1176	203	Dendrœca æstiva, (Gm.) Bd	F.	Rice creek, Anoka Co.	"
1177	213	Myiodoctes pusillus, (Wils.) Bp	F.	Minneapolis	"
1178	189	Dendrœca virens, (Gm.) Bd	F.		"
1179	189	" "	F.		"
1180	208	" palmarum, (Gm.) Bd	M.	Minneapolis	"
1181	208	" "	F.	Sandy lake, Anoka Co.	"
1182	208	" "	F.	" "	"
1183	186	Siurus auricapillus, (L.) Sw	....	Minneapolis	"
1184	186	" " " "	....	"	"
1185	187	" nævius, (Bodd.) Coues	...	"	"
1186	187	" "	....	"	"
1187	240	Vireosylvia olivacea. (L.) Bp	M.	"	"
1188	245	" gilva, (Vieill) Cass	F.	"	"
1189	240	" olivacea, (L.) Bp	M.	"	"
1190	55	Nyctale tengmalmi richardsoni, (Bp.) Ridgw	....	Near Minneapolis	"
1191	57	Nyctale acadica, (Gmel.) Bp	....	"	"
1192	250	Lanivireo solitarius, (V.) Bd	M.	Minneapolis.	"
1193	250	" "	F.	"	"
1194	252	" flavifrons, (V.) Bd	M.	"	"
1195	139	Contopus virens, (L.) Caban	F.		"
1196	148	Hylocichla mustelina, (Gm.) Bd	....	Minneapolis	"
1197	148	" "	....	"	"
1198	154	" aliciæ, Bd	....	"	"
1199	153	" ustulata swainsoni, (Cab.) Ridgw	....	"	"
1200	349	Zonotrichia albicollis, (Gm.) Bp	M.	"	"
1201	369	Melospiza palustris, (Wils.) Bd	....	Near Minneapolis	"
1202	357	Spizella montana, (Forst.) Ridgw	M.	Minneapolis.	"
1203	363	Melospiza fasciata, (Gm.) Scott	....	"	"
1204	363	" "	....	"	"
1205	135	Sayornis fuscus, (Gm.) Bd	....	Sandy lake, Anoka Co.	"
1206	135	" "	....	" "	"
1207	583	Spatula clypeata, (L.) Boie	M.	Medicine Lake, Henn. Co.	"
1208	583	" "	M.		"
1209	577	Anas obscura, Gmel	F.	Sandy lake, Anoka Co.	"
1210	576	Anas boscas, Linn	M.		"
1211	576	" "	M.		"
1212	576	" "	F.	Sandy lake, Anoka Co.	"
1213	578	Dafila acuta, (L.) Bp	M.	Lk. Johannah, Ramsey Co	"
1214	578	" "	M.	"	"
1215	578	" " young.	M.	" "	"
1216	585	Mareca americana, (Gm.) Steph	M.	Lake Amelia, Henn. Co.	"
1217	585	" " young.	M.	" "	"
1218	613	Lophodytes cucullatus, (L.) Reich	M.	Medicine lake, Henn. Co.	"
1219	613	" "	F.	" " "	"
1220	581	Querquedula discors, (L.) Steph	M.	Moore lake, Anoka Co.	"
1221	581	" "	F.	" " "	"
1222	579	Nettion carolinensis, (Gm.) Bd	M.	Minneapolis	"
1223	579	" "	M.	"	"
1224	579	" "	M.	"	"
1225	595	Clangula albeola, (L.) Steph	M.	Sandy Lake, Anoka Co.	"
1226	593	" glaucium americana, (Bp.) Ridgw.	M.		"
1227	593	" " "	M.		"
1228	593	" " "	F.	Lake Minnetonka	"

Register.—Continued.

Collected by.	When Collected.	OBTAINED.		No. of specimens.	Remarks
		When.	Whence.		
Wm. Howling	May 29, 1879.	1884	Wm. Howling	1	By purchase.
"	"	"	"	1	"
"	June 7, 1879.	"	"	1	"
"	1880	"	"	1	"
"	"	"	"	1	"
"	"	"	"	1	"
"	June 4, 1881.	"	"	1	"
"	"	"	"	1	"
"	July 28, 1882	"	"	1	"
"	....	"	"	1	"
"	....	"	"	1	"
"	July 28, 1882.	"	"	1	"
"	May 30, 1878	"	"	1	"
"	....	"	"	1	"
"	....	"	"	1	"
"	June 3, 1879.	"	"	1	"
"	June 14, 1882.	"	"	1	"
"	"	"	"	1	"
"	July 14, 1881.	"	"	1	"
"	"	"	"	1	"
"	June 26, 1882.	"	"	1	"
"	"	"	"	1	"
"	1881	"	"	1	"
"	"	"	"	1	"
"	1879	"	"	1	"
"	....	"	"	2	"
"	....	"	"	1	"
"	Spring 1882.	"	"	1	"
"	"	"	"	1	"
"	June, 1882.	"	"	1	"
"	....	"	"	1	"
"	1880	"	"	1	"
"	"	"	"	1	"
"	June 1, 1881.	"	"	1	"
"	"	"	"	1	"
"	....	"	"	1	"
"	....	"	"	1	"
"	July 28, 1882.	"	"	1	"
"	June 20, 1880.	"	"	1	"
"	"	"	"	1	"
"	June 15, 1883.	"	"	1	"
"	"	"	"	1	"
"	Spring 1882.	"	"	1	"
"	....	"	"	1	"
"	Sept., 1880.	"	"	1	"
"	....	"	"	1	"
"	....	"	"	1	"
"	1879	"	"	1	"
"	Fall, 1881.	"	"	1	"
"	"	"	"	1	"
"	"	"	"	1	"
"	Spring, 1878.	"	"	1	"
"	"	"	"	1	"
"	Fall, 1880.	"	"	1	"
"	"	"	"	1	"
"	Spring, 1877.	"	"	1	"
"	"	"	"	1	"
"	....	"	"	1	"
"	....	"	"	1	"
"	....	"	"	1	"
"	May 26, 1880.	"	"	1	"
"	....	"	"	1	"
"	....	"	"	1	"
"	Fall, 1879.	"	"	1	"

Zoological

Catalogue number.	Original number.	NAME.	Sex.	Locality.	Nature of specimen.
1229	611	Mergus merganser americanus, (Cass.) Ridgw	M.	Long lake, Henn. Co	M't'd
1230	611	" " "	M.	Moore lake, Anoka Co	"
1231	611	" " "	F.	Lake Amelia, Henn. Co	"
1232	611	" " "	F.	L. Johannah, Ramsey Co	"
1233	563	Chen hyperboreus, (Pall) Boie	M.	Windom, Cottonwood Co	"
1234	563	" "	F.	Minneapolis	"
1235	623	Phalocrocorax dilophus,(Sw.& Rich.)Nutt	M.	Rice lake, Hennepin Co	"
1236	698	Colymbus torquatus, Brunn	M.	Lake Minnetonka	"
1237	698	" "	F.	Long lake, Henn Co	"
1238	698	" " young.	M.	Sandy lake, Anoka Co	"
1239	615	Pelecanus erythrorhynchus, Gm	M.	New Ulm	"
1240	615	" "	F.	Fisher's Landing, D. T.	"
1241	590	Fulix collaris, (Donov.) Bd	M.		"
1242	580	Fulix marila, (L.) Bd	M.	Sandy lake, Henn. Co	"
1243	591	Aethyia americana (Eyt.) Bp	M.	Lake Amelia, Henn. Co	"
1244	592	Aethyia vallisneria (Wils.) Boie	M.	Duluth	"
1245	559	Fulica americana, Gm	...	Medicine lake, Henn. Co.	"
1246	706	Dytes auritus. (L.) Ridgw	M.		"
1247	706	" "	M.		"
1248	706	" "	M	Minneapolis	"
1249	695	Hydrochelidon lariformis surinamensis (Gm.) Ridgw	M.	Long lake, Henn Co	"
1250	695	" " "	F.	" "	"
1251	670	Larus philadelphiæ, (Ord.) Gray	M.	Richfield, Henn. Co	"
1252	670	" "	M.	" "	"
1253	670	" " young.	M	" "	"
1254	670	" " young.	M.	" "	"
1255	670	" "	F.	" "	"
1256	....	" "	....	Lake Minnetonka	"
1257	478	Grus americana, (L.) Temm	M	Cedar Mills	"
1258	487	Ardea herodias, Linn	....	Lake Minnetonka	"
1259	487	" "	....	"	"
1260	495	Nyctiardea grisea nævia, (Bodd.) Allen	M.	Lake Amelia	"
1261	495	" " "	F.	Windom, Cottonwood Co	"
1262	493	Butorides virescens, (L.) Bp	M.		"
1263	493	" "	M.		"
1264	493	" "	F.	Minneapolis	"
1265	492	Botaurus lentiginosus (Montag.) Steph	M.	Long lake, Henn. Co	"
1266	492	" "	F.	" "	"
1267	464	Cupidonia cupido, (L.) Bd	M.		"
1268	464	" "	M.		"
1269	464	" "	M		"
1270	464	" "	F.		"
1271	464	" "	F.		"
1272	464	" " young.	M.	Moore lake, Anoka Co	"
1273	463	Pediœcetes phasianellus columbianas, (Ord.) Coues	M.	Dakota	"
1274	465	Bonasa umbrellus, (L.) Steph	M.	Bet. Minneapolis & St. P.	"
1275	465	" "	F.	Minneapolis	"
1276	....	" "	....		"
1277	471	Ortyx virginiana, (L.) Bp	M.	Moore Lake, Anoka Co	"
1278	471	" "	F.	" "	"
1279	471	" "	F.	" "	"
1280	471	" "	F.	" "	"
1281	448	Ectopistes migratoria, (L.) Sw	M.	Rice Creek, Anoka Co	"
1282	448	" "	F.	" "	"
1283	451	Zenaidura carolinensis, (L.) Bp	M.	Sandy Lake, Anoka Co.	"
1284	451	" "	F.	" "	"
1285	519	Steganopus wilsoni, (Sab.) Coues	M.	" "	"
1286	519	" "	M.	" "	"
1287	519	" "	M.	" "	"
1288	519	" "	M.	" "	"
1289	519	" "	F.	" "	"
1290	520	Lobipes hyperboreus, (.L) Cuv. (Young)	M.	Moore Lake, Anoka Co	"

Register.—Continued.

Collected by	When collected.	OBTAINED.		No. of specimens.	Remarks.
		When.	Whence.		
Wm. Howling	1877	1884	Wm. Howling	1	By purchase.
"	April 10, 1882.	"	"	1	"
"	Nov. 5, 1882.	"	"	1	"
"	Nov. 1, 1879.	"	"	1	"
"	Oct. 15, 1880	"	"	1	"
"	Fall, 1874.	"	"	1	"
"	April 27, 1881.	"	"	1	"
"	Oct. 2, 1880.	"	"	1	"
"	Aug. 28, 1881.	"	"	1	"
"	June 30, 1879.	"	"	1	"
"	April 27, 1880.	"	"	1	"
"	June 5, 1875.	"	"	1	"
"	....	"	"	1	"
"	Sept. 17, 1880.	"	"	1	"
"	Spring, 1878.	"	"	1	"
"	Fall, 1879.	"	"	1	"
"	June 13, 1882.	"	"	1	"
"	....	"	"	1	"
"	....	"	"	1	"
"	July 14, 1878.	"	"	1	"
"	June 13, 1879.	"	"	1	"
"	"	"	"	1	"
"	1880	"	"	1	"
"	"	"	"	1	"
"	"	"	"	1	"
"	"	"	"	1	"
"	"	"	"	1	"
J. H. C. Hutchinson	May 15, 1885	1885	J.H. C. Hutchinson.	1	Presented.
Wm. Howling	Sept. 17, 1878.	1884	Wm. Howling	1	By purchase.
"	June 15, 1877.	"	"	1	"
"	"	"	"	1	"
"	July 21, 1878	"	"	1	"
"	April 23, 1881	"	"	1	"
"	....	"	"	1	"
"		"	"	1	"
"	May 20, 1881.	"	"	1	"
"	June 14, 1880.	"	"	1	"
"	June 20, 1881.	"	"	1	"
"	....	"	"	1	"
"	....	"	"	1	"
"	....	"	"	1	"
"	....	"	"	1	"
"	....	"	"	1	"
"	June, 1882.	"	"	1	"
"	Nov. 20, 1880.	"	"	1	"
"	1880	"	"	1	"
"	1878	"	"	1	"
....	July, 1876.	....	....	1	....
Wm. Howling	August, 1880.	1884	Wm. Howling	1	By purchase.
"	....	"	"	1	"
"	....	"	"	1	"
"	....	"	"	1	"
"	July 27, 1881.	"	"	2	
"	....	"	"	1	"
"	August, 1880.	"	"	1	"
"	"	"	"	1	
"	July, 1880.	"	"	1	"
"	"	"	"	1	
"	"	"	"	1	
"	"	"	"	1	
"	"	"	"	1	
"	August, 1882.	"	"	1	

Zoological

Catalogue number.	Original number.	NAME.	Sex.	Locality.	Nature of specimen.
1291	504	Oxyechus vociferus, (L.) Reich	M.	Sandy lake, Hennepin Co	M't'd
1292	504	" "	F.	" "	"
1293	507	Aegialites semipalmatus, Bp	....		"
1294	560	Gallinula galeata, (Licht.) Bp	M.	L Johannah, Ramsey Co.	"
1295	554	Rallus virginianus, Linn	....	Minneapolis	"
1296	555	Porzana carolina, (L) Bd	M.	Near Minneapolis	"
1297	555	" "	F.	"	"
1298	....	" " young	F.	Fond du Lac	"
1299	542	Rallus elegans, Aud	M.	Rice creek, Anoka Co	"
1300	503	Charadrius dominicus, Mull	M.	Sandy lake, Anoka Co	"
1301	503	" "	F.	" "	"
1302	503	" "	M.		"
1303	503	" "	....		"
1304	503	" "	....		"
1305	522	Philohela minor (Gm.) Gray	M.	Rice creek, Anoka Co	"
1306	523	Gallinago media wilsoni, (Temm.) Ridg	M.		"
1307	523	" " "	M.		"
1308	523	" " "	F.	Medicine lake, Henn Co.	"
1309	517	Recurvirostra americana, Gm	M.	Northern Pacific Road	"
1310	547	Limosa fœda, (L.) Ord	M.	Sandy lake, Anoka Co	"
1311	547	" "	F.	" "	"
1312	537	Symphemia semipalmata, (Gm.) Hartl	M.	Moore lake, Anoka Co	"
1313	537	" "	F.	Lk Johannah, Ramsey Co	"
1314	539	Totanus melanoleucus, (Gm.) V	M.	Moore lake, Anoka Co	"
1315	539	Totanus melanoleucus (Gm.) V	M.	" "	"
1316	539	" "	F.	" "	"
1317	539	" "	F.	" "	"
1318	546	Tryngites rufescens, (V.) Cab.	M.	" "	"
1319	530	Pelidna alpina americana, Cass	M.	Sandy lake, Anoka Co	"
1320	530	" " "	F.	" "	"
1321	541	Rhyacophilus solitarius, (Wils.) Cass	M.	Minneapolis	"
1322	541	" "	F.	"	"
1323	543	Tringoides macularius, (L.) Gray	M.		"
1324	543	" "	F.		"
1325	541	Ereunetes pusillus, (L.) Cass	F.	Sandy lake, Hennepin Co	"
1326	....	" " (young).	....		"
1327	....	" " (young).	....		"
1328	390	Cardinalis virginianus, (Briss.) Bp	M.	Virginia	"
1329	390	" "	F.	"	"
1330	160	Sialia arctica, Sw	...	California	"
1331	156	Hesperocichla nævia, (Gm.) Bd	M.	"	"
1332	126	Tyrannus verticalis, Say	M.	"	"
1333	232	Ampelis garrulus, Linn	M.	Minneapolis	Skin
1334	232	" "	F.	"	"
1335	232	" "	....	"	"
1336	303	Hesperiphona vespertina, (Cooper) Bd	M.	"	"
1337	3 3	" "	F.	"	"
1338	348	Zonotrichia querula, (Nutt) Gamb	M.		"
1339	325	Plectrophanes nivalis, (L.) Meyer	M.		"
1340	325	" "	F.		"
1341	233	Ampelis cedrorum, (V.) Bd	F.		"
1342	70	Coccygus erythrophthalmus, (Wils.) Bd	F.		"
1343	380	Zamelodia ludoviciana, (L.) Coues	M.		"
1344	130	Myiarchus crinitus (L.) Cab	M.		"
1345	275	Certhia familiaris rufa, (Bartr.) Ridgw	M.		"
1346	114	Chordeiles popetue, (V.) Bd	M.		"
1347	414	Icterus spurius, (L.) Bp	M		"
1348	414	" " (young)	M.		"
1349	137	Contopus borealis, (Sw.) Bd	M.		"
1350	387	Passerina cyanea, (L) Gray	M.	Medicine lake, Henn. Co.	M't'd
1351	227	Tachycineata bicolor (V.) Cab	....	Lk Johannah, Ramsey Co	"
1352	70	Coccygus erythrophthalmus, (Wils.) Bd	M.	Minneapolis	"
1353	69	Coccygus americanus, (L.) Bp	M.	California	"
1354	325	Plectrophanes nivalis, (L.) Meyer	M.		"
1355	325	" "	F.		"

Register.—Continued.

Collected by.	When collected.	OBTAINED.		No. of specimens.	Remarks.
		When.	Whence.		
Wm. Howling	July 1, 1880.	1884	Wm. Howling	1	By purchase.
"	June 20, 1879.	"	"	1	"
"	....	"	"	1	"
"	1882	"	"	1	"
"	1879	"	"	1	"
"	1877	"	"	1	"
"	"	"	"	1	"
C. W. Hall..........	Sept. 1, 1880.	....	C. W. Hall.........	1	Presented.
Wm. Howling	May 12, 1880.	1884	Wm. Howling.....	1	By purchase.
"	July 1, 1880.	"	"	1	"
"	"	"	"	1	"
"	....	"	"	1	"
"	....	"	"	1	"
"	....	"	"	1	"
"	July, 1880.	"	"	1	"
"	....	"	"	1	"
"	....	"	"	1	"
"	1880	"	"	1	"
"	August, 1878.	"	"	1	"
"	1876	"	"	1	"
"	"	"	"	1	"
"	June 30, 1882.	"	"	1	"
"	May 4, 1882.	"	"	1	"
"	Aug 27, 1881.	"	"	1	"
"	"	"	"	1	"
"	"	"	"	1	"
"	"	"	"	1	"
"	Sept. 27, 1882.	"	"	1	"
"	Summer, 1881.	"	"	1	"
"	"	"	"	1	"
"	1880	"	"	1	"
"	"	"	"	1	"
"	....	"	"	1	"
"	....	"	"	1	"
"	1879	"	"	1	"
....	....	....	....	1	....
....	....	....	....	1	....
....	1880	1884	Wm. Howling	2	By purchase.
....	"	"	"	2	"
....	"	"	"	2	"
....	1876	"	"	1	"
....	1878	"	"	1	"
Wm. Howling	....	"	"	3	"
"	....	"	"	4	"
"	....	"	"	3	"
"	....	"	"	6	"
"	....	"	"	6	"
"	....	"	"	1	"
"	....	"	"	1	"
"	....	"	"	1	"
"	....	"	"	1	"
"	....	"	"	1	"
"	....	"	"	1	"
"	....	"	"	1	"
"	....	"	"	1	"
"	....	"	"	1	"
"	....	"	"	1	"
"	....	"	"	1	"
"	....	"	"	1	"
"	June, 1879	"	"	2	"
"	May 4, 1882.	"	"	2	"
"	July, 1882.	"	"	2	"
....	1876	"	"	1	"
Wm. Howling	....	"	"	2	"
"	....	"	"	3	"

Zoological

Catalogue number.	Original number.	NAME.	Sex.	Locality.	Nature of specimen.
1356	325	Plectrophanes nivalis	...	...	M't'd
1357	303	Hesperiphona vespertina, (Cooper) Bd	M.	Minneapolis	"
1358	303	" "	F.	"	"
1359	124	Tyrannus carolinensis, (L) Temm	M.	"	"
1360	124	" "	F.	"	"
1361	473	Oreortyx picta, (Dougl.) Bd	M.	California	"
1362	474	Lophortyx californica, (Shaw) Bp	M.	"	"
1363	474	" "	F.	"	"
1364	712	Lunda cirrhata, Pall	M.	Kamschatka	"
1365	96	Melanerpes torquatus, (Wils.) Bp	M.	California	"
1366	96	" "	F.	"	"
1367	95	" formicivorus bairdi, Ridgw	M.	"	"
1368	85	Sphyrapicus varius, (L) Bd	M.	Bet. Minneapolis & St. P.	"
1369	220	Pyranga rubra, (L.) V	F.	Minneapolis	"
1370	277	Sitta carolinensis, Gm	M.	"	"
1371	....	Quiscalus purpureus æneus, Ridgw	F.	"	"
1372	401	Agelæus phœniceus, (L.) V	M.	"	"
1373	194	Dendrœca coronata, (L) Gray	M.	"	"
1374	213	Myiodioctes pusillus, (Wils) Bp	M.	...	"
1375	403	Agelæus tricolor, (Nutt) Bp	M.	California	"
1376	413	Icterus cucullatus, Sw	M.	"	"
1377	416	Icterus bullocki, (Sw.) Bp	M.	"	"
1378	437	Aphelocoma californica, (Vig.) Cab	M.	"	"
1379	381	Zamelodia melanocephala, (Sw.) Coues	M.	...	"
1380	386	Passerina amœna, (Say) Gray	M.	California	"
1381	704	Aechmophorus occidentalis, (Laur) Coues.	M.	"	"
1382	256	Harporhynchus redivivus, (Gambr.) Cab	M.	"	"
1383	232	Larus delawarensis, Ord	....	Otter Tail Co., Minn	Skin
1384	256	" "	....	Lake Mille Lac, Minn	"
1385	236	Erismatura rubida, (Wils) Bp	....	Otter Tail Co., Minn	"
1386	246	Corvus corax, L	....	" "	"
1387	257	Buteo borealis, (Gm.) V	....	Borden lake, C. Wing Col	"
1388	196	Otus vulgaris var. wilsonianus	....	Thief river, Minn	"
1389	254	Larus argentatus, Brunn (juv.)	F.	Lake Mille Lac, Minn	"
1390	235	Chaulelasmus streperus, (L) Gray	F.	Otter Tail Co., Minn	"
1391	249	Dafila acuta, (L.) Bp	M.	" "	"
1392	233	" "	M.	" "	"
1393	237	Fuligula affinis	F.	" "	"
1394	238	" "	...	" "	"
1395	184	Steganopus wilsoni, (Cab.) Coues	M.	Norman Co., Minn	"
1396	183	Steganopus wilsoni, (Sab) Coues (juv.)	M.	" "	"
1397	181	Actiturus bartramius, (Wils.) Bd	M.	" "	"
1398	180	Podilymbus podiceps, (L) Laur	....	Ada, Minn	"
1399	182	Xanthocephalus icterocephalus, (Bp.) Bd	....	Crookston, Minn	"
1400	245	Larus philadelphiæ, (Ord) Gray	....	Otter Tail Co., Minn	"
1401	239	Hylotomus pileatus, (L.) Bd	....	" "	"
1402	224	Helminthophaga peregrina, (Wils.) Bd	F.	St. Vincent, Minn	"
1403	188	Turdus fuscescens	....	Ada, Minn	"
1404	250	Hesperiphona vespertina, (Cooper.) Bd	....	Pelican Rapids, Minn	"
1405	252	Picus villosus, L	F.	Lake Mille Lac, Minn	"
1406	163	Sturnella magna, (L) Sw	....	Ada, Minn	"
1407	219	" "	....	"	"
1408	217	" " (juv.)	...	Norman Co., Minn	"
1409	244	Scolecophagus ferrugineus, (Gm.) Sw	M.	Otter Tail Co., Minn	"
1410	229	Zonotrichia albicollis, (Gm.) Bp	....	" "	"
1411	234	Spizella monticola, (Gm.) Bd	....	" "	"
1412	226	Vireo gilvus	M.	Georgetown, Clay Co. Minn	"
1413	209	Passerculus savanna, (Wils.) Bp	F.	Crookston, Minn	"
1414	214	" "	....	Ada, Minn	"
1415	210	" " (juv.)	M.	Crookston, Minn	"
1416	211	" " (juv.)	....	Georgetown, Minn	"
1417	203	" "	....	Ada, Minn	"
1418	212	Ammodramus caudacutus, (Gm.) Sw	....	St. Vincent, Minn	"
1419	213	Troglodytes ædon, Vieill	...	" "	"
1420	....	Spizella pallida, (Sw.) Bp	...	...	"

Register.—Continued.

Collected by.	When collected.	OBTAINED.		No. of specimens.	Remarks.
		When.	Whence.		
Wm. Howling	....	1884	Wm. Howling	1	By purchase.
"	March 25, 1884	"	"	2	"
"	"	"	"	2	"
"	June 1, 1881.	"	"	1	"
"	May 26, 1879.	"	"	1	"
....	1881	"	"	1	"
....	"	"	"	1	"
....	"	"	"	1	"
....	1880	"	"	1	"
....	1882	"	"	1	"
....	....	"	"	2	"
....	1882	"	"	1	"
Wm. Howling	1883	"	"	1	"
"	1879	"	"	1	"
"	1878	"	"	1	"
"	June 1, 1879.	"	"	1	"
"	1879	"	"	1	"
"	....	"	"	1	"
"	....	"	"	1	"
....	1882	"	"	1	"
....	1880	"	"	1	"
....	1881	"	"	2	"
....	1876	"	"	1	"
....	....	"	"	1	"
....	1882	"	"	1	"
....	1876	"	"	1	"
....	1877	"	"	1	"
F. L. Washburn...	Oct. 11, 1885.	1885	Geol. & N. H. Sur.	1	....
"	Nov. 5, 1885.	"	" "	1	....
"	Oct 11, 1885.	"	" "	1	....
"	Oct. 10, 1885.	"	" "	1	....
"	Nov. 5, 1885.	"	" "	1	....
"	Sept. 4, 1885.	"	" "	1	....
"	Nov. 1, 1885.	"	" "	1	....
"	Oct. 11, 1885.	"	" "	1	....
"	Oct. 23, 1885.	"	" "	1	....
"	Oct. 11, 1885.	"	" "	1	....
"	"	"	" "	1	....
"	"	"	" "	1	....
"	Aug. 4, 1885.	"	" "	1	....
"	"	"	" "	1	....
"	"	"	" "	1	....
"	Aug. 10, 1885.	"	" "	1	....
"	Aug. 20, 1885.	"	" "	1	....
"	Oct. 20, 1885.	"	" "	1	....
"	Oct. 11, 1885.	"	" "	1	....
"	Aug. 25, 1885.	"	" "	1	....
"	Aug. 10, 1885.	"	" "	1	....
"	Oct. 27, 1885.	"	" "	1	....
"	Nov. 2, 1885.	"	" "	1	....
"	Aug. 6, 1885.	"	" "	1	....
"	"	"	" "	1	....
"	Aug. 4, 1885.	"	" "	1	....
"	Oct. 11, 1885.	"	" "	1	....
"	Oct. 12, 1885.	"	" "	1	....
"	Oct. 13, 1885.	"	" "	1	....
"	August, 1885.	"	" "	1	....
"	Aug. 18, 1885.	"	" "	1	....
"	Aug. 6, 1885.	"	" "	1	....
"	Aug. 18, 1885.	"	" "	1	....
"	August, 1885.	"	" "	1	....
"	Aug. 6, 1885.	"	" "	1	....
"	Aug. 26, 1885.	"	" "	1	....
"	Aug. 25, 1885.	"	" "	1	....
"	1885	"	" "	1	....

Zoological

Catalogue number.	Original number.	NAME.	Sex.	Locality.	Nature of specimen.
1421	192	Sitta canadensis, L	...	St. Vincent, Minn	Skin
1422	1	Unio rectus, Lam	...	Mississippi R, Brainerd	
1423	2	Unio luteolus, Lam	....	" "	
1424	3	Unio ventricosus, Bar	....	" "	
1425	4	Unio luteolus, Lam	....	Lk.Minnewaska, Pope Co	
1426	5		....		
1427	6	Limnæa stagnalis, Linn	....	Lk.Minnewaska, Pope Co	
1428	7	Helisoma bicarinatus, Say	....	" "	
1429	8	Planorbella campanulata, Say	....	" "	
1430	9	Unio cornitus, Bar	...	Lake Pepin, Lake City	
1431	10	Limnæa stagnalis, Linn	....	Minneapolis	
1432	11	Patula alternata, Say	....	"	
1433	12	Unio rectus, Lam	....	Red river, Wilkin Co	
1434	13	Unio luteolus, Lam	....	" "	
1435	14	Unio lacrymosus, Lea	...	" "	
1436	15	Unio alatus, Say	....	" "	
1437	16	Unio rubiginosus, Lea	....	" "	
1438	17	Helicodiscus lineatus, Say	....	Minneapolis	
1439	18	Unio ventricosus, Bar	....	Red river, Wilkin Co	
1440	19		....		
1441	20	Anodonta edentula, Say	....	Red River, Wilkin Co	
1442	21	Unio undulatus, Bar	....	" "	
1443	22	Unio luteolus, Lam	....	White Bear lake	
1444	23	Limnophysa reflexa, Say	....	" " "	
1445	24	Vivipara intertexta, Say	....	" " "	
1446	25	Limnæa stagnalis, Linn	....	" " "	
1447	26	Planorbella campanulata, Say	...	" " "	
1448	27	Helisoma trivolvis, Say	...	" " "	
1449	28	Mesodon multilineata, Say	....	" " "	
1450	29	Limnæa stagnalis, Linn	....	Northern Boundary, east of Vermillion river	
1451	30	Helisoma trivolvis, Say	....	Minneapolis	
1452	31	Physa gyrina, Say	....	"	
1453	32	Helisoma bicarinatus, Say	....	Minnehaha creek, Henn. Co	
1454	33	Unio luteolus, Lam	....	" " "	
1455	34	Limnophysa reflexa, Say	....	Cedar lake, Minneapolis.	
1456	35	" "	....	Lake City	
1457	36	Physa heterostropha, Say	....	Cedar lake, Minneapolis.	
1458	37	Strobila labyrinthica, Say	....	Minneapolis	
1459	38	Hyalina arborea, Say	....	"	
1460	39	Valvata tricannata, Say	....	Cedar lake, Minneapolis.	
1461	40	Stenotrema monodon, Rackett	....	Minneapolis	
1462	41	Planorbella companulata, Say	....	Kegan's Lk, Minneapolis.	
1463	42	Physa heterostropha, Say	..	Minnehaha creek, Henn. Co	
1464	43	Planorbella companulata, Say	....	" " "	
1465	44	Bulinus hypnorum, Linn	....	Minneapolis	
1466	45	Mesodon multilineata, Say	....	"	
1467	46	Succinea obliqua, Say	....	"	
1468	47	Succinea ovalis, Gould	....	"	
1469	48	Vallona pulchella, Mull	....	"	
1470	49	Cionella subcylindrica, Linn	....	"	
1471	50	Somatogyrus subglobosus, Say	....	Miss. R., Ft. Snelling	
1472	51	Unio alatus, Say	....	Mississippi R., Dresbach, Winona Co	
1473	52	Unio plicatus, Le Sueur	....	" " "	
1474	53	Unio luteolus, Lam	....	" " "	
1475	54	Unio rectus, Bar	.. .	" " "	
1476	55	Unio metanervus, Raf	....	" " "	
1477	56	Unio ligamentinus, Lam	..	" " "	

Register.—Continued.

Collected by.	When collected.	OBTAINED. When.	OBTAINED. Whence.	No. of specimens.	Remarks.
F. L. Washburn...	Aug. 26, 1885.	1885	Geol. & N. H. Sur.	1	....
N. H. Winchell....	Sept., 1877.	Sept., 1877.	" "	14	....
"	"	"	" "	1½	....
"	"	"	" "	20	....
"	....	....	" "	4	....
....	....	....	....	....	....
N. H. Winchell....	....	....	Geol. & N. H. Sur.	1	....
"	....	....	" "	1	....
"	....	....	" "	6	....
Frank Patton......	1884	June, 1885.	Uly. S. Grant.. ...	2	Presented.
Uly. S. Grant......	Sept., 1884.	"	"	20	"
" ...	"	"	"	25	"
N. H. Winchell....	....	....	Geol. & N. H. Sur.	3	20 miles north of Breckenridge.
"	....	....	" "	6	" "
"	....	....	" "	1	" "
"	....	....	" "	2	" "
"	....	....	" "	1	" "
Uly. S. Grant......	July, 1885.	July, 1885.	" "	....	....
N. H. Winchell....	....	....	" "	8	20 miles north of Breckenridge.
....	....	....	....	....	....
N. H. Winchell....	....	....	Geol. & N. H. Sur.	2½	20 miles north of Breckenridge.
"	....	....	" "	4	" "
"	Aug., 1877.	Aug., 1877.	" "	1	....
"	"	"	" "	1	....
"	"	"	" "	75	....
"	"	"	" "	5	....
"	"	"	" "	2	....
"	"	"	" "	16	....
"	"	"	" "	1	....
"	Oct., 1878.	Oct., 1878.	" "	5	....
Uly. S. Grant......	Sept., 1884	June, 1885.	Uly. S. Grant.......	15	Presented.
"	"	"	"	20	"
"	June 21, 1885.	June 21, '85.	Geol. & N. H. Sur.	......	....
O. W Oestlund . ..	July 31, 1885	July 31, '85.	" "	......	....
Uly. S. Grant	June 23, 1885.	June 23, '85.	" "	......	....
Frank Patton......	1884	June, 1885.	Uly. S. Grant......	12	Presented.
Uly. S. Grant......	June 23, 1885.	June 23, '85.	Geol. & N. H. Sur.	......	....
"	July, 1885.	July, 1885.	" "	......	....
"	"	"	" "	......	....
"	"	"	" "	......	....
"	"	"	" "	......	....
"	June 22, 1885.	June 22, '85.	" "	......	....
"	June 21, 1885.	June 21, '85.	" "	......	....
"	"	"	" "	......	....
"	July, 1885.	July, 1885.	" "	......	....
"	"	"	" "	......	....
"	"	"	" "	......	....
"	"	"	" "	......	....
"	"	"	" "	......	....
"	"	"	" "	......	....
"	Aug , 1885.	Aug., 1885.	" "	......	....
....	....	....	" "	2	....
....	....	....	" "	3	....
....	....	....	" "	1	Very old, abnormal and distorted.
....	....	....	" "	1	....
....	....	....	" "	1	....
....	....	....	" "	2	....

Zoological

Catalogue number.	Original number.	NAME.	Sex.	Locality.	Nature of specimen.
1478	57	Unio occidens, Lea	....	Mississippi R., Dresbach, Winona Co	....
1480	59	Unio æsopus, Green	....	" " "	....
1481	60	Unio cornutus, Bar	....	" " "	....
1482	61	Unio ellipsis, Lea	....	" " "	....
1483	62	....	....	....	....
1484	63	Unio ebenus, Lea	....	Mississippi R., Dresbach, Winona Co	....
1485	64	Unio luteolus, Lam	....	Min'sota City, Winona Co	....
1486	65	Lioplax subcarinata, Say	....	Minnesota R., Ft. Snelling	....
1487	66	Mesodon multilineata, Say	....	Minneapolis	....
1488	67	" "	....	"	....
1489	68	Planorbella campanulata, Say	....	Cedar lake, Minneapolis	....
1490	69	Limnæa stagnalis, Linn	....	Lake Bertram, Wright Co	....
1491	70	Unio luteolus, Lam	....	Lake Minnetonka	....
1493	72	Margaritana confragosa, Say	....	Minnesota R., Ft. Snelling	....
1494	73	Unio lævissimus, Lea	....	" "	....
1495	74	Unio alatus, Say	....	" "	....
1496	75	Anodonta corpulenta, Cooper	....	" "	....
1497	76	Andonta imbecilis, Say	....	" "	....
1498	77	Margaritana complanata, Bar	....	" "	....
1499	78	Unio gracilis, Bar	....	" "	....
1500	79	Unio elegans, Lea	....	" "	....
1501	80	Unio zigzag, Lea	....	" "	....
1502	81	Unio luteolus, Lam	....	" "	....
1503	82	Unio rectus, Lam	....	Rum R., Anoka, Anoka Co	....
1504	83	Unio gibbosus, Bar	....	Minnesota R., Ft. Snelling	....
1505	84	Unio anodontoides, Lea	....	" "	....
1506	85	Unio cornutus, Bar	....	" "	....
1507	86	Limnæa stagnalis, Linn	....	" "	....
1508	87	Unio parvus, Barnes	....	" "	....
1509	88	Unio luteolis, Lam	....	Miss. R., Anoka, Anoka Co	....
1510	89	Unio ventricosus, Bar	....	Rum " "	....
1511	90	Anodonta ferussaciana, Lea	....	" " "	....
1512	91	Unio luteolus, Lam	....	" " "	....
1513	92	Unio solidus, Lea	....	Mississippi R. Ft. Snelling	....
1514	93	Unio tuberculatus, Bar	....	Minnesota R., Ft. Snelling	....
1515	94	Unio ventricosus, Bar	....	" "	....
1516	95	Unio securis, Lea	....	" "	....
1517	96	Unio plicatus, LeS	....	" "	....
1518	97	Unio lacrymosus, Lea	....	" "	....
1519	98	Pisidium abditum, Hald	....	" "	....
1520	99	Sphærium transversum, Say	....	" "	....
1521	100	Unio trigonus, Lea	....	" "	....
1522	101	Physa heterostropha, Say	....	Mississippi R., "	....
1523	102	Unio metanervus, Raf	....	Cumber'nd R Nash, Tenn	....
1524	103	Unio trigonus, Lea	....	Mississippi R., Moline, Ill	....
1525	104	Unio crassidens, Lam	....	Duck river, Tenn	....
1526	105	Unio perdix, Lea	....	" "	....
1527	106	Lithasia geniculata, Hald	....	Cumber'nd R. Nash. Tenn	....
1528	107	Angitrema armigera, Say	....	" "	....
1530	109	Io spinosa, Lea	....	Holston R., Knoxville, T.	....
1531	110	Pleurocera subulare, Lea	....	Miss. R., Anoka, Anoka Co	....
1532	111	" "	....	Minnesota R., Ft. Snelling	....
1533	112	Unio graniferus, Lea	....	Miss R., Ft. Snelling	....
1534	113	Patula striatella, Auth	....	Minneapolis	....
1535	114	Bythinella obtusa, Lea	....	Minnesota R., Ft Snelling	....
1536	115	Limnæa megasoma, Say	....	Knife lake, Lake Co	....
1537	116	Sphærium striatinum, Lam	....	Minnesota R., Ft. Snelling	....
1538	117	" "	....	Miss. R., Anoka, Anoka Co	....
1539	118	Physa heterostropha, Say	....	" " "	....
1540	119	Margaritana marginata, Say	....	Minnesota R., Granite F.	....
1541	120	" rugosa, Bar	....	" "	....
1542	121	Unio alatus, Say	....	" "	....

Register.—Continued.

Collected by.	When collected.	OBTAINED.		No. of specimens.	Remarks.
		When.	Whence.		
....	....	....	Geol. & N. H. Sur.	6	....
....	....	....	" "	13	....
....	....	....	" "	2	....
....	....	....	" "	12	....
....	....	....	" "	......	....
....	....	....	" "	100	....
N. H. Winchell....	....	....	" "	1	....
Uly. S. Grant......	Aug., 1885.	Aug., 1885.	" "	......	....
H. V. Winchell	June, 1885.	June, 1885.	" "	......	Without revolving lines.
"	"	"	" "	......	Deformed.
Uly. S. Grant......	"	"	" "	......	....
H. V. Winchell....	June 29, 1885.	July 1, 1885.	H. V. Winchell....	12	Presented.
Uly. S. Grant....	Aug., 1885.	Aug., 1885.	Geol. & N. H. Sur.	......	....
"	"	"	" "	......	....
"	"	"	" "	......	....
"	"	"	" "	......	....
"	"	"	" "	......	....
"	"	"	" "	......	....
"	"	"	" "	......	....
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"	"	"	" "	......	....
"	"	"	" "	......	....
"	"	"	" "	......	....
R. E. Call..........	....	Nov. 9, '85.	R. E. Call..........	3	Presented.
"	....	"	"	5	"
"	....	"	"	1	"
"	....	"	"	1	"
"	....	"	"	9	"
"	....	"	"	12	"
"	....	"	"	1	"
Uly. S. Grant......	Aug., 1885.	Aug., 1885.	Geol. & N. H. Sur.	......	....
"	"	"	" "	......	....
"	"	"	" "	......	....
"	July, 1885.	July, 1885.	" "	......	....
"	Aug., 1885.	Aug., 1885.	" "	......	....
N. H. Winchell....	Sept. 23, 1878.	Sept. 23, '78.	" "	2	....
Uly. S. Grant......	Aug., 1885.	Aug., 1885.	" "	......	....
"	"	"	" "	......	....
"	"	"	" "	......	....
C. W. Hall........	....	Dec., 1885.	C.W. Hall..........	1	Presented
"	....	"	"	1	"
"	....	"	"	6	"

Zoological

Catalogue number.	Original number.	NAME.	Sex.	Locality.	Nature of specimen.
1543	122	Unio tuberculatus, Bar	....	Minnesota R., Granite F.	....
1544	123	Unio ventricosus, Bar	....	" "	....
1545	124	Unio ligamentinus, Lam	....	" "	....
1546	125	Unio plicatus, LeS	....	" "	....
1547	126	Unio rectus, Lam	....	" "	....
1548	127	Anodonta edentula, Say	....	" "	....
1549	128	Helisoma trivolvis, Say	....	" "	....
1550	129	Limnæa stagnalis, Linn	....	" "	....
1552	131	Planorbella campanulata Say	....	Lake Bertram, Wright Co	....
1553	132	Helisoma bicarinatus, Say	....	" "	....
1554	133	" trivolvis, Say	....	" "	....
1555	134	Valvata tricarinata, Say	....	" "	....
1556	135	Unio undulatus, Bar	....	Des Moines, Iowa	....
1557	136	Unio ligamentinus, Lam	....	" "	....
1558	137	Unio rectus, Lam	....	" "	....
1559	138	Unio gibbosus, Bar	....	" "	....
1560	139	Unio luteolus, Lam	....	" "	....
1561	140	Unio ventricosus, Bar	....	" "	....
1562	141	Margaritana complanata, Bar	....	" "	....
1563	142	Mesodon albolabris, Say	....	" "	....
1564	143	Sphærium striatinum, Lam	....	Lake Bertram, Wright Co	....
1565	144	" rhomboideum, Say	....	" "	....
1566	145	" partumeium, Say	....	Minneapolis	....
1567	146	" occidentale, Prime	....	"	....
1568	147	Carychium exiguum, Say	....	"	....
1569	148	Unio luteolus, Lam	....	Minnehaha Crk, Henn.Co	....
1570	149	Helisoma trivolvis, Say	....	Minneapolis	....
1571	150	" "	....	St. Anthony Park, Ramsey Co	....
1572	151	" "	....	Minnesota R., Ft.Snelling	....
1573	152	" "	....	International Boundary, east of Vermillion R	....
1574	153	Planorbella campanulata, Say	....	Minneapolis	....
1575	154	Gyraulus deflectus, Say	....	"	....
1576	155	Physa gyrina, Say	....	"	....
1577	156	" "	....	Mississippi R., Ft.Snelling	....
1578	157	" "	....	Mississippi R., Anoka	....
1579	158	Sphærium striatinum, Lam	....	Rum River, Anoka	....
1580	159	" "	....	Minnehaha Crk, Henn.Co	....
1581	160	Limnophysa caperata, Say	....	Minneapolis	....
1582	161	Gyraulus deflectus, Say	....	Lake Bertram, Wright Co	....
1583	162	Pleurocera subulare, Lea	....	Rum River, Anoka	....
1584	163	Amnicola cincinnatiensis, Auth	....	" "	....
1585	164	Amnicola cincinnatiensis, Auth	....	Minnesota R., Ft.Snelling	....
1586	165	" porata, Say	....	" "	....
1587	166	" "	....	Cedar lake, Minneapolis.	......
1588	167	Unio tuberculatus, Bar	....	Mississippi R., Dresbach, Winona Co	....
1589	168	Anodonta grandis, Say	....	Minnesota City	....
1590	169	" "	....	Zumbro River, Wab. Co.	....
1591	170	Helisoma bicarinatus, Say	....	Buffalo lake, Wright Co..	....
1592	171	Planorbella campanulata, Say	....	" " "	....
1593	172	Valvata tricarinata, Say	....	" " "	....
1594	....	Ursus americanus, Pallas	..	....Minn.	M't'd ....
1595	....	Bos americanus, Gm. (albino.)	....	....	"
1596	....	Ovis montana, Cuv	M.	Maiden, M. T	"
1597	....	Antilocapra americana, Ord	M.	Bismark, D. T	"
1598	....	" " ....Head.	M.	" "	"
1599	....	" " (young) .... "	M.	" "	"
1600	....	" " "	M	Montana	"
1601	....	Cariacus virginianus, (Bodd.) Gray.. "	M.	Minnesota	"
1602	....	" " "	M.	"	"
1603	....	" " (young)...... "	M.	Near Minneapolis	"

Register.—Continued.

Collected by.	When Collected.	OBTAINED. When.	OBTAINED. Whence.	No. of specimens.	Remarks.
C. W. Hall........	....	Dec., 1885.	C. W. Hall.........	1	Presented.
“	....	....	“	4	“
“	....	....	“	5	“
“	....	....	“	1	“
“	....	....	“	3	“
“	....	....	“	1	“
“	....	....	“	8	“
“	....	....	“	3	“
H. V. Winchell....	June 29, 1885.	July 1, '85.	H. V. Winchell....	4	“
“	“	“	“	7	“
“	“	“	“	5	“
“	“	“	“	1	“
Uly. S. Grant......	1883	Dec. 29, '85.	Uly. S. Grant......	8	“
“	1884	“	“	8	“
“	“	“	“	6	“
“	“	“	“	4	“
“	“	“	“	8	“
“	“	“	“	6	“
“	“	“	“	6	“
“	“	“	“	4	“
H. V. Winchell....	June 29, 1885.	July 1, '85.	H. V. Winchell....	2	“
“	“	“	“	1	“
O. W. Oestlund....	July, 1885.	July, 1885.	Geol. & N. H. Sur.	......	....
Uly. S. Grant......	“	“	“ “	......	....
“	“	“	“ “	......	....
O. W. Oestlund....	“	“	“ “	......	Very abnormal.
Uly. S. Grant......	“	“	“ “	......	....
“	“	“	“ “	......	....
“	Aug., 1885.	Aug., 1885.	“ “	......	....
N. H. Winchell....	Oct., 1878.	Oct., 1878.	“ “	......	....
Uly. S. Grant......	June, 1885.	June, 1885.	“ “	......	....
“	“	“	“ “	......	....
“	“	“	“ “	......	....
“	Aug., 1885.	Aug., 1885.	“ “	......	....
“	“	“	“ “	......	....
“	“	“	“ “	......	....
O. W. Oestlund....	July 31, 1885.	July 31, '85.	“ “	......	....
Uly. S. Grant......	June, 1885.	June, 1885.	“ “	......	....
H. V. Winchell....	June 29, 1885.	July 1, '85.	H. V. Winchell....	2	Presented.
Uly. S. Grant......	Aug., 1885.	Aug., 1885.	Geol. & N. H. Sur.	......	....
“	“	“	“ “	......	....
“	“	“	“ “	......	....
“	“	“	“ “	......	....
“	“	“	“ “	......	....
....	....	....	“ “	1	....
N. H. Winchell....	....	....	“ “	2	....
“	Oct. 13, 1875.	Oct. 13, '75.	“ “	1	....
Warren Upham....	....	....	“ “	8	....
“	....	....	“ “	15	....
“	....	....	“ “	30	....
C. L. Herrick......	Jan. 5, 1885.	1885	“ “	1	....
....	....	“	John S. Pillsbury..	1	Presented.
....	Dec., 1882.	1884	Wm. Howling.....	1	By purchase.
....	Feb., 1883.	“	“	1	“
....	“	“	“	2	“
....	“	“	“	1	“
....	1878	“	“	1	“
Wm. Howling	1882	“	“	5	“
“ ...	1875	“	“	1	“ Double growth of horn.
“	1876	“	“	1	By purchase.

Zoological

Catalogue number.	Original number.	NAME.	Sex.	Locality.	Nature of specimen.
1604	....	Cariacus virginianus................ "	M.	Minnesota....	"
1605	....	" " (young)....... "	....	Hinckley, Minn..........	"
1606	....	Cervus macrotis, Say............... "	M.	Montana	"
1607	...	Rangifer caribou, Aud. and Bach ... "	F.	Canada.........	"
1608	....	Canis lupus, L...........................	....	Dakota	"
1609	...	Castor fiber, L	M.	Minnesota...............	"
1610	....	Procyon lotor, (L.) Storr..................	M.	Near Minneapolis........	"
1611	....	" "	F.	Rice lake, Anoka Co	"
1612	....	Taxidea americana, (Bodd.) Baird........	M.	Nicollet Island, M'p'ls...	"
1613	....	Fiber zibethicus, (L.) Cuv...............	....	Lake Calhoun, M'p'ls....	"
1614	....	Mephitis mephitica, Baird................	F.	Minneapolis.	"
1615	....	" " (6 mo. old)............	M.	Moore Lake, Anoka Co..	"
1616	....	" " (young)	....	" " ..	"
1617	....	" " "	....	" " ..	"
1619	....	Arctomys monax, (L.) Gm..................	M.	Minneapolis......	"
1620	....	" "	F.	"	"
1621	....	Putorius vison, Rich......................	M.	Coon creek, Anoka Co ...	"
1622	....	" "	F.	" "	"
1623	....	" ermineus, Cuv. (Summer)..... ...	M.	Minneapolis......	"
1624	....	" " (Autumn)	M.	"	"
1625	....	" " "	F.	"	"
1626	....	" " (Winter)................	M.	"	"
1627	....	Sciurus ludovicianus, Custis.............	....	"	"
1628	....	" hudsonius, Pallas..................	....	"	"
1629	....	" carolinensis. Gm...................	....	"	"
1630	....	Sciuropterus volans, (L.) Coues...........	....	....	"
1631	....	Mus decumanus, Pallas..........	F.	Minneapolis......	"
1632	....	Spermophilus franklini. Cuv	M.	"	"
1633	....	Ursus americanus, Pallas, (young)	F.	"	"

Register.—Concluded.

Collected by.	When collected.	OBTAINED.		No. of specimens.	Remarks.
		When.	Whence.		
Wm. Howling	1875	1884	Wm. Howling.....	1	By purchase. Curious shaped horn.
....	....	....	....	1	....
....	1884	1884	Wm. Howling	2	By purchase.
....	1876	"	"	1	"
....	....	"	....	2	"
Wm. Howling	Jan. 14, 1882.	"	Wm. Howling	1	"
"	1876	"	"	1	"
"	1877	"	"	1	"
"	July, 1875.	"	"	1	"
"	1880	"	"	2	"
"	"	"	"	1	"
"	1881	"	"	1	"
"	"	"	"	1	"
"	"	"	"	1	"
"	1879	"	"	1	"
"	"	"	"	1	"
"	1882	"	"	1	"
"	"	"	"	1	"
"	1881	"	"	1	"
"	"	"	"	1	"
"	"	"	"	1	"
"	"	"	"	3	"
"	1876	"	"	1	"
"	1877	"	"	2	"
"	....	"	"	2	"
"	1875	"	"	2	"
"	June 13, 1873.	"	"	1	" 5 legs.
"	1877	"	"	1	"
"	1874	"	"	1	"

GEOLOGICAL AND NATURAL HISTORY SURVEY OF MINNESOTA.

N. H. WINCHELL, STATE GEOLOGIST.

THE BIBLIOGRAPHY

OF THE

FORAMINIFERA

RECENT AND FOSSIL,

INCLUDING EOZOON AND RECEPTACULITES,

1565—JAN. 1, 1886.

BY ANTHONY WOODWARD.

Part VI of the annual report of progress for the year 1885.

ST. PAUL:
J. W. CUNNINGHAM & CO., STATE PRINTERS,
16 West Fourth Street.
1886.

NOTE.—This paper is introductory to a contemplated work on the foraminifera and other microscopic organisms of the Cretaceous of Minnesota. According to present plans this work will be done by Messrs. Woodward and Thomas, jointly, and it will be published in one of the volumes of the final report of the survey.

N. H. W.

PREFACE.

This bibliography, which is the result of five years of research, is based largely on facilities afforded by the libraries of the American Museum of Natural History and of the New York Academy of Sciences,—facilities which are not enjoyed by many scientific students. At the beginning I had no idea of presenting this work to the scientific world. When I began the study of the foraminifera I had no knowledge whatever of that which had been done in this branch of science. After I commenced looking up the subject the references accumulated so rapidly that I thought it might be well to collect and put them in shape so that they might be useful to others as well as to myself.

After three years' labor I applied to Mr. H. B. Brady, F. R. S., for information pertaining to the subject. He at once informed me that he had in press a bibliography of the same character, and kindly offered to give me any assistance he could.

When the British Association for the Advancement of Science met at Montreal, in 1884, I met in New York Mr. James Thomson, F. G. S., a member from Scotland, to whom I spoke of my work, asking his advice about proceeding with it. He urged me to continue, and to finish it, as it would become accessible to a great number of workers who could not possess the valuable monograph of Mr. H. B. Brady.

I do not presume that this list is complete; since titles are liable to be found in obscure publications that have not fallen

under my notice. Some of those that are here listed may at first appear not to pertain to the subject, but many of the discussions, criticisms, notes, etc., to which reference has been made, although some of them are in general works on microscopy, are of much interest and value to the student, and will be found useful to those who have not access to large libraries.

The list is divided under the following heads:

(1)—Eozoon. (2)—North and South America, Bermuda, Leeward and Windward Islands. (3)—England, Ireland, Scotland and Wales. (4)—France and Italy. (5)—Austro-Hungary, Belgium, Denmark, Finland, Germany, Holland, Netherlands, Norway, Sweden, Switzerland. (6)—Russia and Turkey. (7)—Africa and Asia. The authors names are then arranged alphabetically and their works according to the date of publication.

I must ask those who may notice omissions or detect errors, to kindly inform me of the same so that I may be able to make corrections in a completed supplement.

I am under great obligations, and return my sincere thanks to the following gentlemen who have rendered me invaluable assistance in sending manuscript lists of their papers.

Rev. P. B. Brodie, M. A., F. G. S., R. V., Warwich, England; Dr. R. Haensler, Sussex, England; Prof. W. C. Williamson, Manchester, England; H. J. Carter, F.R. S., Budleigh, Salterton Devon, England; Joseph Wright, F. G. S., Belfast, Ireland; Sir J. W. Dawson, Montreal, Canada; R. J. Lachmere Guppy, F. L. S., F. G. S., Trinidad; M. O. Terquem, Paris, France; Dr. A. Schneider, Breslau; Prof. Dr. H. B. Geinitz, Dresden, Germany; Prof. Dr. Leopold Auerbach, Breslau, Germany; Prof. Hertwig, Bonn, Germany; Prof. Dr. Carl W. Gumbel, Munich, Germany; Prof. Dr. Haeckel, Jena, Germany; Prof. Dr. Valerian Mœller, St. Petersburg, Russia.

It is hoped that this bibliography will be of some service to the student. The writer will then feel that his years of tedious and constant labor have been well repaid.

ANTHONY WOODWARD.

New York, March 1, 1886.

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CONTENTS.

PART I.

EOZOON.

EOZOON.

ANON. Anorganischer Ursprung des Eozoon. <*Verhandl. d. geol k. k. Reichsant.*, p. 58. 1872.

ANON. Eozoon canadense. <*Journ. Roy. Micr. Soc. Lond.*, vol. ii. pp. 275, 276, 744, 745, 902. 1879.

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Publishing a letter from Prof. Max. Schultze, in which he expresses the opinion that "proper wall" of *Eozoon* is of inorganic origin (Nicholson in Whtte and Nicholson's Bib. p. 75.)

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BURBANK, L. S. Views on the *Eozoonal* limestones of Eastern Massachusetts. <*Proc. Bost. Soc. Nat. Hist.*, vol. xiv, pp. 194-198. 1872.

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The author treats more especially of the nummulinæ layer and the canal-system of the "intermediate skeleton," and concludes by summarizing the general evidence in favor of the organic origin of *Eozoon*. (Nicholson in White and Nicholson's Bib. p. 87.)

CARPENTER, W. B. Final Note on Eozoon canadense. <*Ann., and Mag. Nat. Hist.*, ser. 4, vol xiv, pp. 371-372. 1874.

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A recapitulation of the principal facts in support of the belief that *Eozoon canadense* is a *Foraminifer*. (White's Bib. p. 87.)

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Gives reasons for believing that *Eozoon* is not of organic origin. (Nicholson in White and Nicholson's Bib. p. 88.)

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D'ARCHIAC. Note sur l'existence des restes organiques dans les Roches Laurentiennes du Canada. <*Comptes Rendus*, vol. liii, pp. 192–194. 1865.

A note presented by M. D'Archiac on the part of Dr. W. B. Carpenter as to the discovery of *Eozoon canadense*. (Nicholson in White and Nicholson's Bib. p. 90.)

DAWSON, J. W. On the Structure of certain Organic Remains in the Laurentian Limestones of Canada. <*Quart. Journ. Geol. Soc. Lond.*, vol xxi, pp. 51–59, pls. vi, vii. 1865.

The author gives a detailed description of the structure of the bodies described by Sir. William Logan as being organic and as occurring in the Lower Laurentian Limestones. (Quart Journ. Geol. Soc, vol. xxi, p. 45.) The generic name of Eozoon is proposed for these, and the single form described is discussed under the name of *Eozoon canadense*. The author further concludes that Eozoon is probably to be regarded as an ancient type of the *Foraminifera*. (Nicholson in White and Nicholson's Bib. p. 93.)

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DAWSON, J. W. Notes on fossils recently obtained from the Laurentian Rocks of Canada, and objections to the Organic nature of Eozoon. <*Amer. Journ. Sci.*, vol. xliv, 2d ser., pp. 367–376. 1867.

The article also contains notes by W. B. Carpenter; and "Summary" and "conclusion" of King and Rowney, on the same subject; the latter gentlemen opposing, and the former advocating, the organic origin of Eozoon. (White in White and Nicholson's Bib. p. 22.)

DAWSON, J. W. On certain Organic remains in the Laurentian Limestone of Canada. *Canad. Nat.*, new ser., vol. 11, pp. 99–111, 127, 128. 3 wood cuts. 1865.

A reprint from the *Quart. Journ. Geol. Soc. Lond.*, 1865, with some additional notes. A short appendix to the paper follows at pp. 127, 128. (Nicholson in White and Nicholson's Bib. p. 93.)

DAWSON, J. W. Notes on fossils recently obtained from the Laurentian Rocks of Canada, and on objections to the Organic nature of Eozoon, with notes by W. B. Carpenter, M. D., F. R. S. <*Quart Journ. Geol. Soc. Lond*, vol. xxiii, pp. 257-265, pls. xi, xii. 1867.

In the first part of this memoir, Dr. Dawson gives an account of the general appearance and microscopic structure of a specimen of *Eozoon canadense*, found in the Laurentian rocks at Tudor, in which the chambers of the skeleton are filled with a dark colored coarse limestone. The author next deals with certain specimens from Long Lake and Wentworth, and also from Madoc, and concludes by reviewing the objections brought forward by Professors King and Rowney to the organic nature of Eozoon. Dr. W. B. Carpenter adds a note on the appearances presented by thin slices of specimens of *Eozoon* in which the canal-system has been infiltrated with transparent carbonate of lime. (Nicholson in White and Nicholson's Bib. p. 93.)

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DAWSON, J. W., and W. B. CARPENTER. On new specimens of Eozoon canadense, with a reply to the objections of Professors King and Rowney. <*Amer. Journ. Sci*, vol. xlvi, 2d ser., pp. 245–255, 2 plates. 1868.

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DAWSON, J. W. Remarks on Eozoon canadense. <*Nature*, vol. x, p. 103. 1 wood cut. 1874.

DAWSON, J. W. Notes on the occurrence of Eozoon canadense, at Cote St. Pierre. <*Nature*, vol. xii, p. 79. 1875. (Abstract.)

DAWSON, J. W. On the Eozoon canadense. <*Nature*, vol. iii, p. 287. 1871.

DAWSON, J. W. The Story of the Earth and Man.

(Remarks on Eozoon chapter ii, iii, pp. 17–38.) pp. 403, 800. London, 1873.

DAWSON, J. W. The Dawn of Life: being the history of the oldest known fossil remains, and their relations to geological time and to the development of the animal kingdom, pp. 239, with 8 plates and 49 wood cuts. London, 1875.

This work deals principally with the history of the discovery of *Eozoon canadense*, and with all the known facts bearing on its structure and nature. The author first gives a descriptive sketch of the Laurentian formation, accompanied by sections, and a colored map showing the distribution of the Laurentian Limestones in the counties of Ottawa and Argenteuil. Next, a history is given of the various steps which led to the discovery of *Eozoon* and a record of its interpretation by Carpenter and the author

Thirdly, a chapter is devoted to a consideration of the minute structure exhibited by *Eozoon;* and this is compared with the structure of recent *Foraminifera.* The fifth chapter is concerned with the manner in which *Eozoon* has been preserved, and with a consideration of the processes of fossilization by infiltration in general. In the sixth chapter, the author deals with the successors and contemporaries of *Eozoon,* with special reference to *Archæosphærina, Stromatopora, Caunopora,* and *Receptaculites.* Another chapter is devoted to a consideration of the various objections which have been urged against the organic nature of *Eozoon;* and a final chapter treats of certain speculative considerations which may be drawn from the study of this fossil. (Nicholson in White and Nicholson's Bib. p. 95.)

DAWSON, J. W. On Mr. Carter's objections to Eozoon. <*Ann., and Mag. Nat. Hist*, ser. 4, vol. xvii, pp. 118, 119. 1876.

DAWSON, J. W. Notes on the Phosphates of the Laurentian and Cambrian Rocks of Canada. <*Quart. Journ. Geol. Soc. Lond..*, vol. xxxii, pp. 285–291. 1876.

Concludes that the phosphatic material found in these rocks in Canada is of organic origin, and has been produced by the agency of marine invertebrates. (Nicholson in White and Nicholson's Bib. p. 95.)

DAWSON, J. W. Notes on the Occurrence of Eozoon canadense at Cote St. Pierre. <*Quart. Journ. Geol. Soc. Lond.*, vol. xxxii, pp. 66–74, plate x, with 4 wood cuts. 1876.

The author gives an account of the nature and arrangement of the strata at Cote St. Pierre, with special reference to the appearance presented by *Eozoon* as occurring *in situ.* Numerous chrysotile veins pass through the limestone, but the author concludes that they are altogether subsequent to the fossil in origin. The close resemblance of weathered specimens to *Stromatopora* is insisted upon; and two new forms of *Eozoon canadense* are described as var. *minor* and var. *acervulina.* The limestone sometimes contains numerous little globose casts of chamberlets, single or attached in groups, each of which possesses the structure of the "proper wall" of *Eozoon.* For these the author proposes the name of *Archæosphærinæ.* (Nicholson in White and Nicholson's Bib. pp. 95, 96.)

DAWSON, J. W. On some new specimens of Fossil Protozoa from Canada. <*Proc. Am Assoc. Adv. Sci.*, vol. xxiv, pp. 100–106, wood cuts. 1876.

The author gives general description and illustration of *Eozoon canadense,* and also *Foraminifera,* from Cretaceous rocks. He advocates the organic origin of *Eozoon.* (White in White and Nicholson's Bib. p. 22.)

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A critical notice of a memoir by Hahn (see post.) in which the latter endeavors to show that *Eozoon* is a purely mineral structure. (Nicholson in White and Nicholson's Bib. p. 96.)

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Dawson, J. W. Canadian and Scottish Geology. An Address delivered before the Edinburgh Geological Society at the close of the Session, 1884. <*Trans. Edin. Geol. Soc.*, vol. v, pp. 113, 114. 1885.

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[*Supposed to be Eozoon.]

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Fritsch, A Ueber Eozoon bohemicum aus dem Kornigen Kalke von Raspenau in Bohmen. <*Landesdurchforschung von Bohmen*,—Geol. Sect., pp. 245-251, 1 wood cut and 2 plates. 1869.

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Gumbel, C. W. Eozoon im ostbayer. Urgebirge. <*N. Jahrb. fur Min. etc.*, 1866. I. S. 1 und *N. Jahrb. fur Min., etc.* 1866. S. 210.

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Gumbel. On the Occurrence of Eozoon in the Primary Rocks of Eastern Bavaria. *Quart. Journ. Geol. Soc. Lond.*, vol. xxii, pp. 23, 24. 1866.

A review by H. M. J.

Gumbel, C. W. On the Laurentian Rocks of Bavaria. <*Cand. Nat.* new series, vol. iii, pp. 81–101, 1 plate. 1868 Translated from the proceedings of the Royal Bavarian Academy for 1886, by Prof. Markgraf.

[*Editor's Note.—In revising and preparing this for the press, the original paper has been considerably abridged by the omission of portions, whose place is indicated in the text. Some explanatory notes have also been added.—T. S. H.]

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HAHN, DR. O. Giebt es ein Eozoon canadense? Eine mikrogeologische Untersuchung. <*Wurttembergische naturwiss.* Jahreshefte, 32 Jahr, pp. 132–155. (Translated by W. S. Dallas, Ann. and Mag. Nat Hist , ser. 4, vol. xvii, pp. 265, 282) 1876.

After an examination of serpentinous limestones from Canada and Europe, the author concludes that *Eozoon canadense* is of organic origin. (Nicholson in White and Nicholson's Bib. p. 103.)

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Plate xxx., fig. 5, Eozoon canadense, reputed canal system of Eozoon; fig. 6 the same. Both stones from which the slides were taken were collected by me in Little Nation. Let one compare the canal system of the nummulite fig. 3 with this reputed canal system! Figs. 3 and 5 should be the same thing.

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PART II.

NORTH AND SOUTH AMERICA, INCLUDING BERMUDA, LEEWARD AND WINDWARD ISLANDS.

NORTH AND SOUTH AMERICA.

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This work is necessarily principally concerned with British forms, but not exclusively so. At page 47 is a summary of geological localities in North America which have yielded Carboniferous or Permian *Foraminifera*. The following forms are described from the Carboniferous Rocks of North America: *Valulina palæotrochus*, Eheb., *V. deccurrens*. *V. plicatæ*. Brady. *V. bulloides*, n. sp., *V. rudis*, n. sp., *Nodosinella priscilla*, Dawson. *Calcarina ambigua*, n. sp, and *Endothyra bowmani*, Phill. The last is shown to be the subsequently described *Rotælia baileyi*, Hall, from the Spergen Hill Limestone of Indiana. (Nicholson in White and Nicholson's Bib. p. 86.

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PART IV.

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PART V.

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PART VI.

RUSSIA AND TURKEY.

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PART VII.

AFRICA AND ASIA.

AFRICA AND ASIA.

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ERRATA.

Page 177, line 10 from top—before word proper insert the.
Page 178, line 3 from top—for xxv read xv.
Page 178, line 4 from bottom—for Rocks read Limestones.
Page 179, line 15 from top—for xl read xl.
Page 179, line 16 from top—for This read The.
Page 180, line 20 from top—for S. W. read J. W.
Page 181, line 23 from top—for appearance read appearances.
Page 181, line 1 from bottom—for 66 read 68.
Page 182, line 8 from bottom—for 1886 read 1868.
Page 183, line 8 from bottom—for organic read inorganic.
Page 185, line 22 from top—for Notizer read Notizen.
Page 190, line 5 from bottom—for J. B. read J. W.
Page 191, line 4 from top—for 1871 read 1875.
Page 191, line 5 from top—for 1872 read 1876.
Page 191, line 6 from top—for Englypha read Euglypha.
Page 191, line 10 from top—for *Pascedlas* read *Pasceolus.*
Page 191, line 16 from top—for viii read vii.
Page 191, line 26 from top—for *Valulina* read *Valvulina.*
Page 191, line 27 from top—for *deceurrens* read *decurrens.*
Page 191, line 28 from top—for *plicatæ* read *plicata.*
Page 191, line 30 from top—for *Rotælia* read *Rotalia.*
Page 192, line 9 from top—for *Mantelii* read *Mantelli.*
Page 192, line 28 from top—after Pembina insert Mountain.
Page 193, line 18 from top—for Tadaissac read Tadoussac.
Page 193, line 12 from bottom—for Meridinale read Meridionale.
Page 194, line 10 from bottom—for Krede read Kreide.
Page 194, lines 12, 13 from top—for*polythalmia* read *polythalamia.*
Page 196, line 1 from top—for 2881 read 1881.
Page 196, line 14 from top—for *Lepidoiites* read *Lepidolites.*
Page 197, line 6 from top—for Om read On.
Page 197, line 1 from bottom—for Carribean read Caribbean.
Page 198, line 10 from top—for South read Southern.
Page 198, line 8 from bottom—for Foraminifera read Foraminiferen.
Page 200, line 2 from top—for Murry read Murray.
Page 201, line 14 from top—for Palaontologre read Palaontologie. Analysister read Analysirter.
Page 204, line 17 from top—for tublos read tubulosa.
Page 206, line 3 from bottom—for vii read iv.
Page 208, line 23 from top—for vii read viii.
Page 210, line 19 from top—for Polders read Polytremata.
Page 211, line 2 from top—for Roy read Ray.
Page 212, line 24 from top—for Polythemata read Polytremata.
Page 212, line 1 from bottom—for v read iii.
Page 213, line 13 from bottom—for 1882 read 1883.
Page 214, line 4 from bottom—for House read Howse. Kirkly read Kirkby.
Page 216, line 1 from top—for Prestwick's read Prestwich's.
Page 217, line 10 from top—for Mendon read Meudon.
Page 217, line 8 from bottom—for Tumanowiczie read Tumanowiczii.

Page 218, line 10 rom top—for Kirkly read Kirkby.

Page 218, line 2 from bottom—insert pp 264-266, 1 plate. For xxi read xx.

Page 219, line 11 from bottom—for Southerndoun read Southerndown.

Page 219, line 15 from bottom—for S R read St.

Page 219, line 1 from bottom—for xvi read xxvi.

Page 220, line 8 from top—for Britanica read Britannica.

Page 220, line 9 from top—for xl read xi.

Page 221, line 6 from top—for Protozon read Protozoa.

Page 222, line 5 from top—for xl read xi.

Page 222, line 6 from bottom—insert xiv.

Page 224, line 6 from top—for Snyopsis read Synopsis.

Page 224, line 19 from bottom—for 297 read 292.

Page 224, line 13 from bottom—insert Park.

Page 224, line 11 from bottom—for D read Dr.

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GENERAL INDEX.

VII.

NEW SPECIES OF FOSSILS.

By N. H. WINCHELL.

CRYPTOZOON MINNESOTENSE, n. sp.

Plates I and II.

(Compare *Cryptozoon proliferum,* Hall, thirty-sixth regents' report on the New York State Cabinet, plate VI.)

In 1875, and again in 1877 specimens of doubtful organic forms were collected by the writer at Northfield from the magnesian limestone beds that outcrop along the left bank of the Cannon river a mile and a mile and a half below the city. These were registered in the General Museum of the University with the numbers 2391, and 2563 without special description. In May, 1885, the same form was seen more abundantly in the uppermost layers of similar limestone at Cannon Falls, in Goodhue county, and was registered as a "supposed stromatopora," with the number 5865. In both cases this fossil has been found in the upper layers of this limestone, directly beneath the St. Peter sandstone, which can be seen in both places, in outcrop but a few rods away. The museum is indebted to Mr. W. H. Scofield of Cannon Falls, for the finest and largest perfect specimen of this fossil that has yet been seen. A specimen having the same laminated structure and from the same formation (so far as could be judged from the lithology and the geographical position) was found in the drift in Fillmore county; and silicified masses of laminated rock are referred to in the report on that county in vol. i of the final report, p. 283, where they are compared to *Eozoon canadense.* It is highly probable that all these belong to the same generic form, and probably to the same species, though there is a constant difference in outer

shape between those seen at Northfield and those at Cannon Falls.

The specimens obtained at Northfield (Pl. II., fig. 4) are sub-cylindrical with a conical upward apex. They are from one to three inches long, the length depending apparently on the circumstances that attended their removal from the enclosing rock, and from one to two inches in diameter. They appear, outwardly, like a succession of cups, or thimbles, piled on each other, the lower end of each covering the upper, closed end of the one below it. But the lower edge of each cup is ragged and capriciously fractured, due to the weathering out of the specimen from the enclosing rock, for it is probable that the specimens would not be discovered except for the distinctness of the cup-shaped lamination which is made conspicuous by exposure to the weather. It is evident that they are not always cylindrical, nor sub-cylindrical, since the impressions of the apices of several, remaining on the under surface of a small slab of rock, are somewhat elongated, though the most of these are concave, and shaped like the conical tops of the most of the detached specimens. The frayed edges of the laminæ vary in frequency and in thickness. Generally two or three occupy the space of a quarter of an inch, but the intimate structure shows, in a thin section, a much finer lamination, viz.: from six to ten laminæ in a quarter of an inch.

The specimens from Cannon Falls show a similar but much finer lamination, the laminæ being as frequent as six or eight laminæ in a quarter of an inch, as visible to the eye. In a thin section the fine lines indicating the sections of the laminæ are as numerous as ten to fourteen in a quarter of an inch (Pl. II, Fig. 3). Furthermore the Cannon Falls specimens are quite different in outward form. They are shaped like the fossil from the Trenton which is well known under the name *Chætetes petropolitanus,* but attain an immense size. The largest perfect specimen seen, detached, is that kindly furnished by Mr. Scofield, who found it at Cannon Falls, weathered out from the Shakopee limestone, and is nearly sixteen inches in diameter across the base, and eight inches in hight. Its form is well represented by figure 42 (A),* on page 317 of Mr. Nicholson's *Palaeozoic*

*Now separated by Mr. Nicholson under the name *Monticulipora* (*Diplotrypa*) *Whiteavesii.*

tabulate corals. Numerous others of equally symmetrical outlines, varying in size from three inches to ten inches in transverse diameter have been gathered at Cannon Falls. They are also seen to overlap each other and to be of various shapes when crowded in the rock. The surface of the rock is nearly covered with them over a space of a square yard or more at a point in the highway near the depot of the Chicago, Milwaukee and St. Paul railway. The under surfaces of perfect specimens are concentrically striated or ridged. This form has been seen at Mankato where it occurs in the upper portion of the bluffs, in the limestone that is used for quicklime, the diminished representative of the Shakopee limestone. It is more common than that seen at Northfield, and the name *minnesotense* is applied to it. The resemblance of the Northfield form to the Phrygian cap suggests for this variety the distinctive term *libertatis.*

These forms may be varieties of Prof. Hall's species *proliferum;* but they differ markedly from that in the manner of growth. They are convex upwardly, instead of concave, and while having apparently a main central point of attachment from which growth proceeded, they spread laterally over the surface, and each grand added layer of growth seems to be expressed in the concentric undulations seen on the base, which has a central depression rising toward the center of the mass.

Prof. Hall has kindly supplied me with a specimen and a mounted thin section of *Cryptozoon proliferum,* for comparison, from which it is seen that the lamination is quite similar in general character, but much finer in the Minnesota forms.

Locality and formation: Cannon Falls, Northfield, and Mankato in the Shakopee limestone.

Museum Register numbers 2391, 2563, 5865, and 6487.

RHYNCHONELLA AINSLIEI, n. sp.

Plate II, figs. 5 and 6.

Of this species only the exterior is known. It varies from a quarter of an inch, or less, to three quarters of an inch in transverse dimension. Mature specimens measure somewhat more than half an inch from front to rear. The plications are finer and more numerous than in *R. capax,* with which it is constantly

associated, but from which it can easily be distinguished by this obvious character. It is also a broader shell, generally, and, like *R. Capax*, has not been known to acquire in Minnesota those rotund proportions which the latter exhibits in Indiana and Ohio.

The smaller, or dorsal, valve has an upward, rounded flexure at the center which extends from the front about three-fourths of the distance to the beak, where it blends with the general convex surface of the valve. The corresponding flat depression of the ventral valve can be traced perhaps a little further toward the beak. On the dorsal valve are from 28 to 34 plications, of which six or seven are on the mesial fold. On the ventral valve, which has a distinct, free, perforate, curved beak, are about the same number of plications, of which six or seven are in the depressed mesial lobe. On each valve, the outer ones of those plications embraced in the mesial fold are partly on the sloping surface from the fold to the general surface of the valve. The mesial flexure of the valves is much less marked in the young specimens.

The beak of the dorsal valve is wholly hid by the curvature of the beak of the ventral valve. The beak of the ventral valve is perforated at the apex by a circular foramen which, however, is coalescent with the deltidium, which extends to the hinge-line with slightly diverging lateral margins. On either side of the deltidium of the ventral valve is a curving faintly striated lamella, simulating a cardinal area such as is seen in Orthis.

The plications of the shell are crossed diagonally by fine striations of growth, but in no case have these striations been seen so conspicuous and ornamental as in some specimens of *R. capax* from Ohio. Indeed they are hardly visible except under a magnifier.

Locality: This fossil is found throughout the southeastern part of the State wherever the Trenton shales appear in outcrop, and extends as far north as Minneapolis where it is common in the shales that overlie the Trenton limestone.

Museum numbers 324, 734, 4031, 5480, 5489, 5521, 5492, 5512, 5505, 5517.

The specific name is given in honor of Mr. N. S. Ainslie, of Rochester, Minn., at the request of Prof. R. P. Whitfield.

ORTHIS REMNICHA, n. sp.

Plate II, fig. 7.

Shell about an inch in transverse diameter and about three-quarters of an inch in length, from front to rear; it is regularly oblong-oval, with the greater diameter transverse, marked by coarse, bifurcating costæ which radiate from the beak. The ventral valve has a shallow mesial depression which begins near the beak and widens toward the front so as to occupy on the front margin nearly a third of the width of the shell. The beak is not prominent, and in all the specimens seen, which are rather poor, it seems not to rise beyond the hinge area; the cardinal angles are rounded, so far as preserved in any specimens seen.

No other characters of this shell can be given, as it is only seen in fragments which are but rarely large enough to satisfactorily characterize the genus *Orthis*. Very many impressions and fragments of its valves are found in a brownish magnesian limestone at Red Wing, which lies beneath the surface of the grade of the street, from two to six feet, at the corner of Brush and Main streets. This limestone was excavated in the construction of the city sewers, and seems to be a lenticular layer but a foot or two in thickness.

Formation: This layer is in the St. Croix formation, about 125 or 150 feet below the limestone which there rises in the summits of the bluffs.

Museum Register numbers 6041 and 6070.

Before this the only mention of Orthis at this low horizon seems to be that of Prof. A. Winchell, who has described *Orthis barabuensis** from Devil's lake, Wisconsin. (*Am. Jour. Sci.*, vol. xxxvi, p. 229. 1864); *Orthis pepina,* described by Prof. James Hall in 1863, (Sixteenth Report on the New York State Cabinet, p. 134,) who reported it from Reed's Landing, Minnesota, and Osceola, Wisconsin; *Orthis coloradoensis,* described by B. F. Shumard from Burnet county, Texas, (Trans. St. Louis Acad., vol. 1, p. 627), who incidentally (*loc. cit.*) referred to an Orthis "from the Potsdam sandstone of Minnesota," found in casts in a fine-grained sandstone, but which he never described, and *Orthis*

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*Prof. R. P. Whitfield (Geol. of Wis., vol. iv, p. 171,) regards this as more likely to be a *Leptæna*

eurekensis, recently published by C. D. Walcott, from the Eureka district of Nevada. (Palæontology of the Eureka District, p. 22). The species described above differs widely from all these, and cannot be mistaken for either of them.

ORTHIS SANDBERGI, n. sp.

Plate II, Figs. 8 and 9.

Associated with the last are distinct impressions of a four-lobed brachiopod which is doubtfully referred to the genus *Orthis*. The greatest width of the shell is on the hinge-line, amounting to half an inch or somewhat less; from the ends of which the margins of the valves retreat abruptly, producing acute cardinal angles. After a shallow re-entrant angle, or curve, the lateral margins swell out again in passing the anterolateral spaces, forming rounded lobes, one on each side of the median line. As they approach the center of the front, they again crowd inward forming at the front an indentation. These lobes on the larger valve are coincident with elevations on the exterior of the shell, and the retreating angles with depressions, both of which extend from the margin to the beak, the aspect in general being rather spiriferoid or four-lobed. The specimens are all casts or impressions, the shell substance having been absorbed. These impressions are smooth, though there is in one case an appearance as if the outer surface of the large valve were marked by radiating costæ. The beak is apparently inconspicuous.

Formation and locality: Same as the last.

Museum register number 6490.

The name is given to this species in honor of Dr. J. H. Sandberg, of Red Wing, who called attention to this inconspicuous fossiliferous bed. Associated with this and the last, are occasional traces of what appear to be crinoidal remains, in the form of sections of the stems, about an eighth of an inch in diameter.

VIII.

A SUPPOSED NATURAL ALLOY OF COPPER AND SILVER FROM THE NORTH SHORE OF LAKE SUPERIOR.

BY N. H. WINCHELL.

In the course of preparation of the exhibit of the Minnesota department of geology, fauna and flora, at the late exposition at New Orleans, I obtained at Duluth a mass of native copper, similar to numerous others that have been found in the drift-deposits in the northwest. This was loaned for the use of the exposition, and was exhibited during its continuance. It is owned by Hon. G. C. Greenwood of Duluth, and is said to have been found near the mouth of Temperance river, in Minnesota.

This piece of copper had been assayed to ascertain its content of silver, which was evidently present throughout the most of the specimen. Several holes had been drilled through it for the purpose of getting a fair average by the use of the drillings, and the prevalent opinion of the amount of the silver was stated, from recollection, to be five pounds of silver and three pounds of copper, and it was thus labeled, while on exhibition at New Orleans, the official statement of the assayer having been lost.

On the return of this specimen from New Orleans I was struck with the appearance which it presents. The two metals are plainly, but not homogeneously, alloyed. It has been stated that these two metals are never thus found alloyed, though in immediate contact, in the copper-bearing rocks of Lake Superior.

Dr. C. T. Jackson, who was the first to call public attention to this point, so far as I have been able to ascertain, stated in 1849,*

*Report on the geological and mineralogical survey of the mineral lands of the United States, in the State of Michigan, 1849, pp. 386, 461,

"that only one other locality is known in the United States of a mixture of native copper and silver, and that is in Somerville, N. J." He saw a mass of native copper taken from the old Bridgewater mines which had numerous lumps of silver projecting from its surface, though firmly united to the copper at the point of contact. He calls attention to a "series of facts altogether new in practical geology, viz., the occurrence of veins of solid metalic copper, admixed with native silver and not alloyed with it." He affirms that he has "analyzed hundreds of specimens without ever finding any true alloy of the copper and silver. In cases where it was first supposed to have been an alloy, it was subsequently found to be merely a mechanical mixture of the two metals. Had they no affinity for each other the particles could not have been more separate, but since we know that molten copper and silver readily and most quickly unite, forming an alloy when they are brought in contact, and know also that the copper requires a much higher temperature for its fusion, it is difficult to conceive that the metallic lode of the mine was deposited in a molten condition."

Messrs. Foster and Whitney in their report on the Lake Superior land district* in 1850, refer to the unalloyed condition of copper and silver in these rocks Though it had been asserted that some of the native copper contains a small portion of silver alloyed with it, they found no silver in the specimens which they examined unless particles of that metal were visible in the mass. A specimen of native silver from the Minnesota mine was found to contain a trace of copper; though in general, they stated these metals do not occur alloyed with each other, as would naturally be supposed on the theory that they have been forced up together in a state of fusion from the heated interior of the earth. "The silver is scattered through the metalic copper in such a manner that each metal remains entirely free from alloy with the other, although the junction of the two at their edges is a perfect one. The silver is often interspersed in the mass of copper so as to form a species of porphyry, the former metal occurring in small patches and particles perfectly soldered to the enclosing mass of copper, yet, chemically speaking, entirely distinct from it."

*Report on the "copper lands" of the Lake Superior land district in Michigan, 1850, p. 178.

Prof. R. Pumpelly never found these metals in the least alloyed together, though constantly occuring in intimate union.* *Dana's mineralogy* mentions no instance of silver and copper found naturally alloyed. Pumpelly states that the union between them is often so slight that on being rolled out into a sheet the silver becomes more or less separated and may be wholly detached.

Under these circumstances, when those who have carefully studied the metallurgy and paragenesis of these substances in their native places have not been able to find a single instance of a natural alloy, the conditions which can be seen plainly shown by this specimen are certainly a matter of surprise and of scientific interest. On asking Prof. Dodge, of the University of Minnesota, to make an assay of this specimen, he stated that he made the former assay, nearly two years ago, and he kindly gave me the following statement of the two trials which he made. He drilled six one-fourth inch holes through it, to obtain the drillings for each assay:

FIRST RESULT.

Copper	99.04 per cent.
Silver	.06 per cent.
Iron	traces.
Gold	none.

SECOND RESULT.

Copper	99.004
Silver	.096
Iron	traces.
Gold	none.

The average proportion of silver is less than one per cent, but it is evident that in some parts of the mass the silver is much more, and would perhaps reach from five to ten per cent. There are also some evidently nearly pure silver streaks or blotches, which are revealed by freshly abraiding the surface.

This mass having been found on the surface mingled with the drift pebbles, there is no certainty that it is natural. Indeed there are some outward signs, in the specimen itself, aside from

*Geological survey of Michigan, Vol. I, copper bearing rocks, pp. 110, 35.

the *a priori* improbability, that it may have been in the hands of the ancient miners who once wrought the copper-mines of Lake Superior, and that its present condition is due to their mining methods.

(1.) In the first place, it is in the form of a sheet from a fourth to a half an inch in thickness, of the shape nearly of an equilateral triangle.

(2.) It is coiled at one corner so that the corner nearly touches the opposite side, and has the appearance of having been forced into this shape.

(3.) If this were uncoiled, the straightened edge would form nearly a right line, about eight inches in length, a fact which is improbable with a piece of native copper in its original condition.

(4.) This edge, and also another edge for a distance of about two inches, has a roughly laminated, or sheeted structure, such as might have been produced by some pounding and crowding when in a semi-molten condition.

(5.) There is, all over the exterior, on one side of the specimen, a roughness of fine reticulated corrugations, alternating ridges and furrows, not long continuous, but broken, varying from a thirty-second part of an inch apart to an eighth of an inch, simulating a somewhat disturbed fluidal surface cooled. In some cases these little furrows enclose rounded, or somewhat polygonal spaces, as two or more systems seem to cross each other, resembling the shrinkage crack of drying clay, or the basaltic structure of the top of a lava flow.

(6.) On the other side, where there are some traces of malachite, this surface structure is almost wanting; but instead of it there is a coarse, but smoother, imprint of irregular forms that may have been due to the nature of the rock or other substance on which, as a molten mass, it may have lain.

When, in connection with these indications, it be remembered that the ancient miners who were probably the ancestors of the present Indians, used to extract the copper from the rock by the aid of fire, it seems very reasonable to suppose that this piece had been thus affected, and that it had been dropped by them in their journey from Isle Royale to the southern or western tribes. Such pieces were seen in the hands of the Indians in the 16th

century, by Cartier and Champlain. One of the chiefs drew from a sack a piece of copper a foot long and gave it to Champlain. When he was more questioned as to its source, the chief answered that they had gathered it in lumps, and having melted it, spread it out in sheets, smoothing it with stones.*

This piece not only appears to confirm the report of Champlain as to the primitive methods of metallurgy of copper, but perhaps will throw some light on the so-called *hardening*, or tempering, of copper which has been attributed to the early miner. Mr. P. R. Hoy, of the Wisconsin Academy of Sciences, argues that the ancients did not melt their copper, nor cast the implements they made, but attributes to them the skill necessary for "swedging" hatchets, &c., in moulds, hardening their edges by hammering. It may be that a slight alloy of silver, taken so as to affect the edge of the implement, could be as readily made to harden it as the supposed pounding in the process of swedging.

Owing to doubts expressed by some archæologists as to the genuineness of this find, on the occasion of the reading of the foregoing paper at the Ann Arbor Meeting of the American Association for the Advancement of Science, in the Summer of 1885, the following sworn affidavits were obtained of parties who were concerned in handling it since its discovery, and of the person who found it:

STATE OF MINNESOTA, COUNTY OF ST. LOUIS.—SS.

L. Augustus Taylor, being duly sworn, deposes and says that he is a resident of Duluth, Minnesota, that he discovered an alloy specimen, now reported as the Greenwood specimen in the University of Minnesota Museum, as deponent is informed and believes, that he discovered the same in the year 1883 in the Temperance river in the bed of the stream about two miles from the mouth of the stream, and about one mile from the North Shore Silver and Copper Mine in Cook county, Minnesota. That this deponent gave the specimen to B. B. Spalding and is informed by the latter that he gave the same to George Greenwood and that no change of any kind was made in said specimen from the time this deponent obtained it until he delivered it to said Spalding.

L. A. TAYLOR.

*Voyage du Sieur de Champlain, Paris, 1613, p. 246.

Sworn to and subscribed before me this 1st day of October, 1885.

SHUBAD F. WHITE,
[Notarial Seal.] Notary Public,
St. Louis Co., Minn.

STATE OF MINNESOTA, COUNTY OF ST. LOUIS.—ss.

B. B. Spalding, being duly sworn, deposes and says that he received the specimen of alloy mentioned in the foregoing affidavit from L. Augustus Taylor who made said affidavit and delivered the same unchanged, except by the cutting off of a piece weighing about one-half pound, to George Greenwood of Duluth.

B. B. SPALDING.

Subscribed and sworn to before me this 1st day of October, 1885.

SHUBAD F. WHITE,
[Notarial Seal.] Notary Public,
St. Louis Co., Minn.

STATE OF MINNESOTA, COUNTY OF ST. LOUIS.—ss.

Geo. C. Greenwood, being duly sworn, deposes and says that he received the specimen referred to in the foregoing affidavits, from B. B. Spalding, the affiant in the last above affidavit, and delivered the same unchanged to Prof. N. H. Winchell of the University of Minnesota, and that the same was, when he last saw it in the University of Minnesota Museum, within a week past, in the same condition as when he delivered it to said Prof. Winchell, with the exception of a small hole since drilled in it.

G. C. GREENWOOD.

Subscribed and sworn to before me this 1st day of October, 1885.

SHUBAD F. WHITE,
[Notarial Seal.] Notary Public,
St. Louis Co., Minn.

IX.

REVISION OF THE STRATIGRAPHY OF THE CAMBRIAN IN MINNESOTA.

By N. H. WINCHELL.

In the ascent of the Minnesota valley for the purpose of geological examinations, in 1873, two different formations of limestone were met with, separated by a white sandstone. These were designated from the towns at which their characteristic outcrops occurred, the Shakopee limestone, the St. Lawrence limestone, and the Jordan sandstone. The thickness of neither one of these was known accurately, but the Shakopee limestone was said to be "about seventy feet," the Jordan sandstone "about seventy feet," and of the St. Lawrence limestone not more than fifteen feet could be affirmed.

In subsequent years as the survey progressed southeastwardly through Fillmore, Houston and Winona counties, these three parts were distinctly recognized, and this three-fold division was described at Lanesboro, Troy, Lewiston (near Stockton), and in western Wabasha county. In ascending the Mississippi valley in the progress of the survey, the intervening sandstone, as recognized in the southeastern part of the State, and the Shakopee limestone, gradually lose the development which they were seen to have in the southeastern part of the state, and the "Lower Magnesian" as defined by Dr. Owen, seems to become one great limestone stratum by the union of the two limestones through the omission of the Jordan sandstone. This omission, however, is not found to prevail everywhere even in the more northern counties, since in Goodhue and Washington counties this sand-rock is plainly preserved, and has an observed thickness of five to ten feet, occurring in lenticular strata.

Again, about in the same proportion and rate of progress, as the sandstone separating the two limestones shrinks in thickness, another limestone is developed in the Mississippi bluffs at a considerably lower horizon, increasing toward the north and northwest. This change has been the cause of some mistaken identifications of stratigraphy by the survey, both in the Mississippi valley and in the Minnesota valley, and it is the intention of this revision to correct these, and to exhibit, briefly, the stratification of this portion of the Cambrian as it is developed in Minnesota, so far as the facts at hand will allow. For the purpose of adjusting some of the apparent discrepancies the writer recently made a cursory re-examination of those points in the Minnesota valley which were likely to throw light on the problem. The stratigraphic facts brought out by this re-examination are expressed below. Prior to this Mr. Upham had called attention to the great apparent thickness of the Shakopee limestone as developed by deep wells at Shakopee, which would make it parallelize with the chief limestone formation in the bluffs of the Mississippi at Hastings, instead of with the upper member which had been traced, under the name of Shakopee limestone, from Houston county to Hastings, and had shown by a study of the deep wells of the central part of the state that a calcareous member, comparable to the St. Lawrence limestone at St. Lawrence, exists below that which had been regarded its equivalent in the Mississippi bluffs.

With the facts all in mind, it was deemed best to make a special search, in the Minnesota valley, for the thin upper sandstone which had been found gradually thinning out toward the north, and that overlying upper limestone which had been identified since 1873, as the Shakopee limestone in the valley of the Mississippi, and to ascertain their actual relations to the Shakopee at Shakopee, and to the St. Lawrence at St. Lawrence. It is evident, whatever might be the result, that the extension of the strata there seen, and those only, would constitute the Shakopee and St. Lawrence limestones in their development further southeast and east.

This search was successful, but before the sandstone was actually found *in situ*, a fresh examination was made of the quarries at St. Lawrence. This was sufficient to show to any

one familiar with the lower-most of the limestones of the Mississippi valley, quarried at Lake City and at Hokah, that the actual St. Lawrence limestone must be parallelized with it and not with the great limestone member which forms the conspicuous escarpments of the great valley. This is evident not only from its lithology but also from its thickness, and from facts which were observed afterward at higher points in the Minnesota valley. This being established, it is evident that the sandstone which directly overlies it (the Jordan) must be the upper portion of the St. Croix in the Mississippi bluffs, having a thickness of nearly a hundred feet.

Having thus once determined the equivalents of the St. Lawrence and the Jordan, in the Mississippi valley, it also became evident that the regular order would require that the principal limestone in one place should parallelize with that of the other, and that hence the great limestone, as supposed to exist at Shakopee could be no other than the great stratum seen at Hastings.

The existence of the great thickness of this limestone at Shakopee rests on the uncertain testimony of the deep wells there which have penetrated it. But although the details of these wells are not obtainable so as to show the possible existence or non-existence in this limestone of any thin beds of sandrock, yet they unite with sufficient testimony to demonstrate that there is under Shakopee village, extending far below any rock exposed in the quarries, a stratum of limestone, or what the well-drillers denominate wholly limestone, that is entirely comparable to that in the bluffs at and near Hastings, and should be parallelized with it. The quarries at Shakopee involve only from 15 to 20 feet of the uppermost layers of this stratum, and to these layers the term *Shakopee* should be applied—and only to these, or, at most, to those underlying layers that extend downward to the thin sandstone which is known to exist, with more or less persistence, in this great formation, about 25 feet below its top (see reports on Fillmore, Houston, Winona, Wabasha, Olmsted, Goodhue, Dakota and Washington counties) and which has been supposed hitherto to represent the Jordan, but which is really another and distinct member of the Cambrian.

It was for the purpose of seeking for evidence of this thin

sandstone in the Minnesota valley that the recent examination was made. At Shakopee there is no direct evidence of this sandstone. All the evidence there is is that derived from the deep wells, which do not mention it; but it is well known that a thin stratum of sandstone, only five to ten feet thick, might be pierced by a drill, in sinking a deep well without the knowledge of the operator, the difference in the *chuck* of the drill, and the infrequency of pumping not being sufficient to detect it when the underlying and overlying strata were similar and somewhat arenaceous limestones.

However, at a short distance above Shakopee, at the Louisville limekilns, and between them and the river, before the appearance of the Jordan sandstone in the river, this limestone underlying the city of Shakopee is significantly divided into two parts, each part extending horizontally over considerable distances forming a marked terrace-flat. These parts exhibit different outward lithological aspects and intimate stratigraphic structure. The upper one is that which is wrought for quick lime at the lime-kilns at Louisville, and rises to the hight of 75–100 feet above the other. It is set off markedly from the other by a bluff which is composed largely of river-terrace gravel, and is so hid by this material that its existence is known only at a few places. It apparently exists as island-like remnants in this region, since it was not found in Mr. Jacob Thorn's well situated in section 15, Jackson, Scott Co., just east (a little north) of the quarries at Louisville, which went through gravel and sand 130 feet, blue clay 4 feet, and then entered a reddish limerock in which the drill was working at a depth of three feet at the time of this visit, and which is the equivalent of the lower reddish rock seen in the terrace that separates the limekilns from the river. The thickness of lime rock involved in this upper terrace of Louisville cannot be seen to exceed 30 feet, but it rises, apparently, about as high as the top of Mr. Thorn's well, and may exceed that thickness. The stone is very irregular in its bedding, and like the real Shakopee limestone, answering to the descriptions, given before, of the exposures at Shakopee, at (or near) Quincy, in Winona county, and at Northfield. The beds undulate, swell out, anastomose, become vesicular, then compact, change to shale which is green, are interbedded with shale, &c., &c., and do not resem-

ble at all the main body of limestone along the Mississippi bluffs. These rough upper beds swing back from the river in their line of strike, a little to the northeast of Merriam Junction, and are not known to occur in outcrops again, in their entirety, in the Minnesota valley. These are the beds which properly and correctly represent the Shakopee limestone, and they manifest their tendency to retreat from sight here, and further up the Minnesota valley, in the same manner as they have been seen to do in all places in the Mississippi valley. It is the lower limestone, that which forms the lower terrace at Louisville, which returns in force along the Minnesota valley above the rapids near Carver. The only evidence, at Louisville, of the existence of any intervening sandstone consists in the fact of the separation of this formation into two terrace-like expanses, one of which continues thence invisible, and the other extends as an independent formation as far as Mankato. The disintegrating action of a few feet of crumbling sandstone in an otherwise homogeneous limestone formation, along a great valley of erosion is a well known agent in causing the retreat of the upper portion, in its line of strike, farther away from the river. When the beds overlying the sandrock are themselves more irregular and likely to be carried away on the removal of the crumbling sandrock, the retreating habit of these upper layers is easily accounted for.

The limestone in the lower terrace, west from the Louisville kilns, is reddish, resembling the rock at Kasota, and rises about 45 feet above the flat on which the Minneapolis and St. Louis railroad passes from Carver, about a quarter of a mile distant, on its course to Merriam Junction. By reason of the dip this also soon passes off eastward, giving place to the Jordan sandstone, which is conspicuously exposed in many places. In regular order, the dip continuing in the same direction, the lower-most limestone appears at St. Lawrence, about four miles further west. At Belle Plaine, the salt well struck no limestone. The river runs over the St Croix, presumably, for several miles above Belle Plaine, the beds of which are so erosible that they do not make their appearance through the heavy drift-sheet which prevails generally in that part of the state. Not mentioning the conjectural exposure of rock in the bluff at Rocky Point, near Blakeley, which was not visited on the recent trip, the next

appearance of the limestones of the valley is on the west side, where, at Faxon, and again at points somewhat further south, in Jessenland, are outcrops of thin-bedded limerock, as recorded in the second annual report, which appertain, with great probability, to the horizon of the St. Lawrence limestone. There is no further outcrop, so far as known, before reaching Ottawa, where the beds that are the equivalent of the layers of the lower terrace at Louisville return and are wrought by numerous quarries. Considerable time was spent in examining these quarries, where may be found some remnants of the Cretaceous filling cavities in the older rock in the same manner as at Mankato. These quarries show all the characters of the stone quarried at Kasota. They are underlain by a white sandstone, which displays itself in the bluff to the thickness of 55 feet (including the talus) at the quarry of Mr. Schwartz, three-fourths of a mile below the station. This sandstone contains isolated patches and and also some thin leaves or laminations of green shale which fades to white. It was evidently deposited in an agitated water, as it contains sudden changes in the sedimentation-lines, even angular fragments of itself, one and two inches across, that are discordant with the enclosing sedimentation. It may be on the parallel with that conglomerate seen at the crossing of Van Oser's creek, near Louisville, in the upper part of the Jordan sandstone where, (recently) were seen some pebbles of red granite over an inch in diameter, and scales of ochery shale, or rusted soft rock, embraced in the white sandstone.

The limestone quarried at Ottawa lies in heavy but undulating layers, similar to those at Kasota, and furnishes a good building stone. These are near the bottom of the limestone to which they belong. The Shakopee beds probably exist in the eastern and southern (higher) portions of the Le Sueur prairie, which thus repeats the upper prairie at Louisville, while the flat on which Ottawa is situated owes its existence to the same cause as the lower terrace at Louisville.

After another interruption of five miles the same horizon returns at St. Peter, the beds having a fair exposure in the low river bluffs near the asylum. At the highway bridge at St. Peter there is no limestone preserved; the bluff on which the bridge rests at the west end consisting wholly of sandrock. On the top

of this sandrock is a thin deposit of reddish shale which amounts to about four feet, as it can be traced back from the river up a little ravine. Back from the river it is lighter colored. This is believed to be Cretaceous, though there is no evidence of it except its anamalous stratigraphic position. It may be a representative of the shale overlying the Jordan sandstone at the cement works at Mankato, though at no other point, north of the cement works, has such a shale been seen immediately overlying the Jordan—not even in the northern confines of Mankato. The limestone beds overlying this sandstone were not re-examined. Some information concerning them can be found in this report, at page 12, where the record of the hospital deep well is printed. It is probable that No. 3 of that record is the true St. Lawrence limestone, but that it was not wholly a magnesian limestone; also that the St. Peter rock, as quarried at the asylum, is the equivalent of the Kasota and Mankato quarries, and that, hence the true Shakopee beds will be found in the upper prairie level back of the asylum, into the composition and origin of which those beds enter with the same agency as at Louisville and at Ottawa. Indeed, the prevalence of large northern boulders on the hillsides and on the upper prairie flats back of St. Peter, points to the same cause as where they are strewn over the Shakopee terrace, between Shakopee and Louisville, and at other places that could be mentioned, where the immediate cause thereof is known to be the underlying firm beds of magnesian limestone. The sandstone seen at the old asylum quarry in 1873 (see the second annual report, p. 132), is also now regarded as Cretaceous. It has not been seen since 1873, but the sandstone of the lower Cretaceous is well known to cover all the Cambrian strata unconformably, in this part of the state, (see the report on Blue Earth county, vol. 1, final report), and traces of it are visible as far north as the quarries at Louisville, where pockets of white sand are found in the upper portion and are reported on the top of the quarried beds of the Shakopee. Similar patches of arenaceous Cretaceous are found at the asylum farm near St. Peter, and were fully identified as such in 1873. Second annual report, p. 177.*

*Capt. Beatty states that there is a large deposit of sandstone, more or less disintegrated, probably of Cretaceous age, in the bluffs east of the railroads at Mankato.

The river only intervenes between St. Peter and Kasota, and all the characters seen at the former place are repeated at the latter.

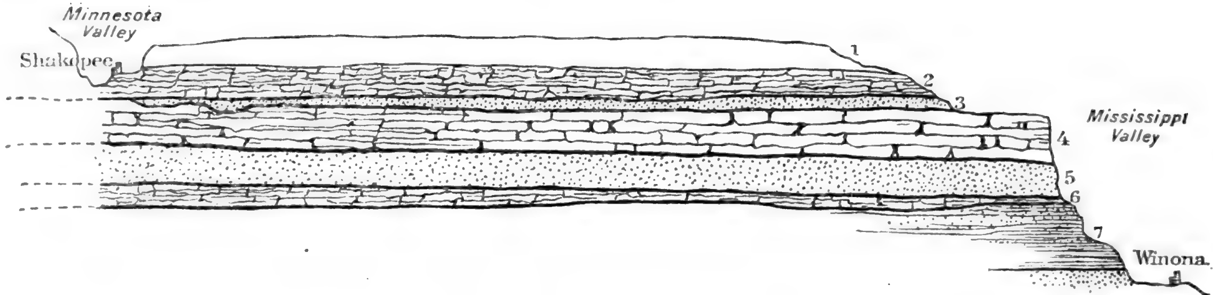
From Kasota to Mankato, a distance of six and a half miles, no great change is apparent. The St. Peter and Kasota terrace continues all the way to Mankato, and its uniform composition is manifested not only by the outward terrace-like aspect, but by several important quarries, and by exposures along the river bluff, intermediate. The difference between the limestone at Kasota and Mankato is one of difference of thickness. At Mankato the bluff contains an aggregate of about sixty feet of the limestone corresponding to the limestone of the lower terrace at Louisville, and at Kasota this limestone shows not more than twenty-one feet. In both cases they lie on the Jordan sandstone.

The most interesting observations respecting these limestones were made at Mankato. In the first place owing to the great thickness of the quarried beds, it was probable that the terrace north from the city was nearly on the level of the supposed thin sandstone stratum which had been presumed to exist between the true Shakopee limestone and the beds there quarried. Hence a careful search was instituted for traces of this sandrock. It was not long before angular or sub-angular masses of white arenaceous quartzyte were met with in traveling over the prairie north from Mankato, resembling the angular pieces that have been described at about the same horizon, weathered out from this sandstone in Winona and Houston counties. In several places were found bared spaces of this white hard sandrock, or quartzyte, forming the natural surface of the prairie, this being wholly above the beds quarried at the city. In several other places still further north, were found isolated low mounds of magnesian limestone rising three to six feet above the rest of the prairie, while about their flanks, near the level of the prairie, were bare areas of the same flat-lying, white, hardened sandrock, so situated as to show that it continued uninteruptedly beneath, and formed the base of the mounds. These mounds are therefore remnants of the true Shakopee limestone and this hardened white sandstone, here not more than four feet in thickness, and sometimes wanting entirely by reason of the surface destruction

due to the action of the river in early times, is the western extension of the thin sandstone which had been so often described in counties further east and styled Jordan. Still further north, and a little further from the river, the limekiln which was formerly owned by Geo. C. Clapp, sec. 17, Kasota, is probably based on the limestone overlying this sandstone, and hence on the true Shakopee. Further evidence of the parallelism of these upper beds with the true Shakopee consists in the fact that the fossil described in another part of this report, *Cryptozoon minnesotense*, is found in loose weathered fragments on the prairie on which these mounds occur, and it has before been found only in the Shakopee at Cannon Falls and at Northfield.

After the discovery of these facts, all the topography and geology of the Minnesota valley are in harmony with themselves, and with the same in the Mississippi valley. Some changes must be made in the designations applied to the limestones in both valleys, and new designations must be found for the two new strata thus added to the upper Cambrian. The following general diagrammatic section will express the comparative and correlative geology of these beds in the two great valleys:

Fig. 10.



EXPLANATION OF FIGURE 10.

1.	Drift and Trenton and St. Peter	
2.	Shakopee limestone	20—40 feet.
3.	White sandstone	0—40 feet.
4.	Magnesian limestone	75—175 feet.
5.	Jordan sandstone	75—100 feet.
6.	St. Lawrence limestone (shaly)	0—30 feet.
7.	Sands and Sandy shales	at least 200 feet.

Notes on the Foregoing Figure: The St. Croix formation includes all below No. 4, and extends down to the great sandstone which is struck in deep wells at Red Wing and Lake City, and appears at Hinckley and in the gorge of the Kettle river in Pine county. This lower great sandstone is more likely to be the Potsdam of New York state than the sandstone No. 5, or any part of this section.

No. 2 is the Shakopee limestone at Shakopee, as there exposed, and as described in the counties in the southeastern part of the State, in the reports of progress and in vol. 1 of the final report. It is the limestone burned for quicklime at Northfield and at Louisville. It is the same as the Willow river limestone, of L. C. Wooster. (Geol. Wis., vol. iv, p. 106).

No. 3 is a white sandstone which has not, till recently, been identified in the Minnesota valley, but it has been described, erroneously, as the Jordan sandstone in the southeastern part of the State. It was first described at Lanesboro, in 1875, under that name, but as the Jordan sandstone lies lower it is obviously necessary to find some other designation for this member. In the report of the Wisconsin Geological Survey for 1877, Mr. L. C. Wooster describes a similar white sandstone in the upper part of the lower Magnesian, near New Richmond, in Wisconsin, and remarks that this may represent the Jordan sandstone of Minnesota (as the Jordan had then been described in Fillmore and Houston counties), but he applied no designation. However, in the final report of the Wisconsin Survey, (vol. iv, pp. 106, 127), Mr. Wooster applies the term *New Richmond beds*, to this sandstone, and that term might be extended, being prior in its correct application, to this sandstone in Minnesota.

No. 4. This is the limestone which is generally known as the Lower Magnesian. It was supposed, till lately, to be the actual extension of the St. Lawrence limestone into the eastern part of the State, and has been so named in the reports of progress, and in vol. 1 of the final report. It has never received a distinguishing appellation—except that Prof. Irving has styled it the "Main body of limestone," (*Am. Jour. Sci.*, June, 1875, p. 440), though at Madison, where this term was applied, it is no more than 85 feet thick. It is the limestone which forms the lower terrace at Louisville, which is wrought at Ottawa, appears at St. Peter, and

extends conspicuously along the Minnesota river from Kasota to Mankato. Along the Mississippi it forms the precipitous escarpments at the tops of the bluffs.

No. 5. The Jordan sandstone is the upper most member of the St. Croix. The name Jordan was applied to this in 1873, in the annual report of that year. Prof. Irving has named it Madison sandstone in Wisconsin. (*Am. Jour. Sci.*, June, 1875, p. 440.) This sandstone has been correctly described throughout the Minnesota valley in all the reports of progress, but it was wrongly identified in the eastern part of the state.

No. 6. The St. Lawrence limestone was so named in the report of progress for 1873. It is the same that Prof. Irving named, in 1875, "Mendota limestone." This limestone is unfavorably exposed in the Minnesota valley. Its greatest thickness, known there, is only about 15 feet, but it seems to extend, with some shaly components, distinctly over a thickness of about 30 feet in the Mississippi valley; while, if the shaly beds with which it is associated, and into which it seems to graduate, be included under this term, it will include beds to the amount of nearly 200 feet. This is the chiefly fossiliferous portion of the St. Croix formation. It is found at Red Wing, to contain some new fossils, described in another part of this report. It is quarried at Lake City and contains *graptolites*, and at Hokah, where it affords *Dikellocephalus.*

No. 7. These shales and shaly sandstones graduate upward into the St. Lawrence limestone, as above mentioned. They are underlain by a gray micaceous sandstone which is known recently as the *Dresbach sandstone*, from a town in Winona county, where it is wrought for construction.

There are therefore, in Minnesota and Wisconsin, three magnesian limestones, and four saccharoidal sandstones, not including some shales and lower sandstones, involved in regular alternation in the Cambrian, thus—

St. Peter sandstone.
Shakopee limestone.
New Richmond beds.
Main body of limestone.

St. Croix.	Jordan sandstone. (Potsdam?) St. Lawrence limestone. Shales. Dresbach sandrock. (Potsdam?)
	Shales.
	Hinckley sandrock. (Potsdam?)
	Red shales and red sandrock passing into the Cupriferous? (Potsdam?)

X.

NOTES OF A TRIP UP THE THIEF RIVER AND AT LAKE MILLE LACS.

By F. L. WASHBURN.

MINNEAPOLIS, Nov. 27, 1885.

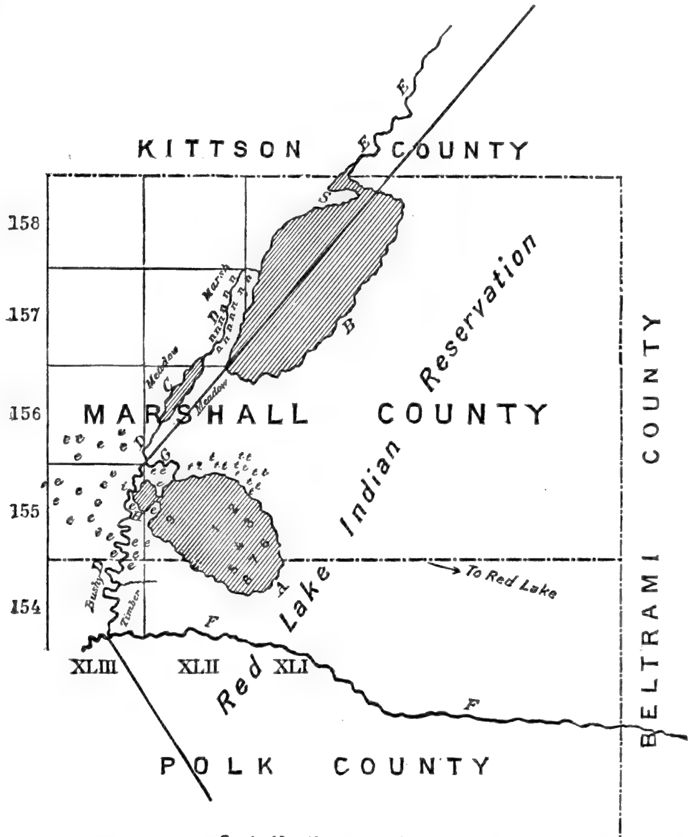
Prof. N. H. Winchell:

DEAR SIR.—At your request I send you the following account of the Thief River region and append thereto a map which may be somewhat of an auxiliary to my necessarily rather meagre description of the country.

Thief river forms part of the southwestern boundary of the *Red Lake Indian Reservation*, and has a general north and south direction. At the northeast corner of T. 43, R. 155, it is met by Mud river, a small stream, 10 yards wide, a mile and a half long and about 2½ feet deep, flowing from Mud lake and entering the Thief from the east. My northward progress, as you know, was stopped here and I was compelled, by bad weather and lack of time, to turn back. Beyond this point, to the north, the river is reported to be navigable for a canoe through Basil lake and as far as Thief lake. In other words, Thief river is navigable its entire length, from Thief lake to its mouth, on the Red Lake river.

Thief lake is a body of water about 14 miles long and 6 wide, a favorite resort for aquatic fowl. Its shores are reported more or less wooded with hard and soft timber and much of the shore lies in unsurveyed territory. At its very northern extremity, hidden behind the point S (Poplar Point), an opening is found which takes one into Moose river, flowing from the north, which

Map of Thief River Country.



Scale 12 miles to one inch.

Explanation of the Map.—A, Mud lake; B, Thief lake; C, Basil lake; DD, Thief river; EE, Moose river; "very crooked, sluggish and deep for 25 miles from its mouth." FF, Red Lake river; G, Mud river; about 10 yards wide, 2 feet deep and 2½ miles long, flowing from Mud lake to the Thief river. H, a muddy estuary of Mud lake, connected with it by a reed-grown passage containing a few small grassy islands and opening into Thief river by a narrow passage (*i*) just wide enough for two canoes to pass one another.

1, 2, 3, 4, 5, large islands in Mud lake, numbered in order of their relative size, No. 1 (the only one visited), containing about 1½ acres; all the larger islands apparently have timber upon them. 6, 7, 8, smaller islands; 9, a grassy knob or knoll, of which there seem to be many.

n n n n n, high banks along Thief river, just after leaving Thief lake, "covered with hard-wood timber." The narrow strip of land (marked p p) between the lake and the river is covered with oak, ash and elm.

S, Poplar Point.

t t t t t, tamarac, and back of it the ground rises a little. e e e e e, impassable marshy land, filled with reeds, rushes and tall grass, running west from Mud lake 8 miles or more before striking straggling timber.

is said to be a stream "very crooked, sluggish and deep for 25 miles from its mouth at Thief lake," from which I infer that it must have a total length of 40 miles or more. The country about it is as yet unsurveyed.

Basil lake, on the Thief, between Mud lake and Thief lake, has meadows and marshy land on both sides of it. The banks along Thief river, just below Thief lake and between that body of water and Basil lake, are high and "covered with hardwood timber," and the point of land between Thief river and Thief lake (marked p p) on the map, is timbered with oak, ash and elm. Beyond these high banks on Thief river, *i. e.*, west of them, the country is marshy.

Supposing one to be descending the river in a canoe, a ride of about 25 or 30 miles from Thief lake brings him to Mud river and turning into that stream he reaches Mud lake after a half hour of paddling. This lake is nearly 10 miles long and 4 to 6 wide, with an average depth of 4 feet. The bottom is soft mud but the water is clear and sweet. The banks are fringed with cane, rushes and wild rice, though the center of the lake is free from such growth. The surface of the lake is dotted with numerous islands, ten or more. Some were grassy knolls or knobs rising from the water (as No. 9), while others attain the hight of three or four feet above the surface, contain an acre or more of land, and are covered with tall timber. On the northeast side of Mud lake is a dense forest of tamarac and back of it slightly rising ground. Island No. 1 was the only one visited, rough weather during my short stay there not allowing of much canoeing. This island contained about an acre and a half and was covered with ash, elm, willow, and, I think, oak. In places on it I found large limestone rock; its beaches were composed of a clayey sand, and from its northern end ran a large sand-bar, on which were a few granite boulders about four feet in diameter.

The islands are apparently more numerous at the eastern end than near the outlet on the northwestern shore, and I have so indicated them on the map.

The muddy estuary *H.* on the west end of the lake and connected with it by a very shallow weed-grown passage, has a depth scarcely twelve inches, contains numerous low, grassy islands, roosting places of aquatic fowl, and opens again into

Thief river, about a mile below the mouth of Mud river by a narrow passage, which I have marked (i) on the map, just wide enough for two canoes to pass one another.

Paddling down the Thief from the mouth of Mud river, one reaches, in a few minutes, the narrow opening (i) through which a glimpse of the muddy estuary H is obtained. Continuing down stream, the canoe gliding swiftly along with the current, the banks are lined for a distance of about twenty miles with tall cane, six or eight feet high, which stretches back some distance from the river. This occurs on both sides but is rather more abundant on the Reservation side. On this part of the river there is no timber with the exception of a little scrub willow, mostly at a distance from the stream.

After that distance of twenty miles has been passed however, and after going through a region which has been burnt over and has dead tamarac standing upon it, the timber is continuous, almost entirely on the Reservation side, for a distance of ten miles or more, to Red Lake river into which the Thief empties. This timber consists of willow, poplar, elm, ash, sugar maple, and oak, with small growth of Prickly Ash (Xanthoxylum americanum), hazel bushes, high bush cranberries (Viburnum opulus), wild plums (Prunus americana), wild grapes and rosebushes.

On the opposite side of the river, most of the land of any value has been claimed. The farms are comparatively few in number, however, the land being so covered with brush that farmers have a hard time to obtain a living therefrom.

The river gradually widens from a width of ten yards at the entrance of Mud river to about thirty yards at its mouth on the Red Lake river. The current is fairly strong and the average depth is about two and one-half feet. In places there are rapids where occur large boulders of granite (from two to four feet in diameter) and limestone rock. These rocks and boulders, however, are not found in the river as one approaches Mud lake. The bed of the river is sandy with gravel in some places and the banks are clayey mud with occasional small fragments of limestone. The water of the river is slightly yellowish, and at date of visit (Sept. 1) very cold. At the mouth of the river, there is, or was this fall, an encampment of Red Lake Indians, and about eight miles up stream is another village which subsist

on fish and game, the former procured from a stone fish trap which runs across the river here in the shape of a V, the point down stream. This is easily passed in a canoe, however by temporarily removing a number of branches and rock, on one side. On our way to Mud lake we passed the remants of several of these traps that had been used for a time by the Indians and then abandoned.

The only drawback to this country becoming a favorite resort for sportsmen is its inaccessibility, for though it is comparatively easy to get to the mouth of the river, going by rail as far as St. Hilaire, and then teaming to the mouth, a distance of 18 miles, the transportation of camp equipage to Mud lake or beyond is a matter of no small difficulty. There are but few farms along the river, the last one being situate about 20 miles from the mouth. The people are very hospitable however, and never refuse a lodging, such as it is, to belated or weatherbound travelers. Again, though Mud lake lies, in a straight line only 15 miles from the mouth of Thief river, the country around the lake is of such a marshy nature, that teams can approach only within about 10 miles of the lake on the Thief.

These difficulties surmounted however, the large number of aquatic fowl along the river and at the lake would amply repay an enthusiastic sportsman for his trouble.

Very truly yours,

F. L. Washburn.

A few notes on Otter Tail County and Lake Mille Lacs—Topography—Archæology, etc.

Otter Tail County: The abundance of flint arrowheads and fragments of ancient pottery throughout this county I noticed particularly, though for that matter these relics are abundant throughout the State, I believe. The pieces of pottery that I saw contained specks of pure silver, and scientists and many others, not scientists, when visiting that country have sought long but fruitlessly for the clay beds whence material for this pottery was obtained, thinking to find therein a boundless wealth of the ore.

Lake Mille Lacs: The country east of Brainerd, toward Mille Lacs, is rather bleak and dreary. Patches of second growth, and scrubby, bushy timber characterize the first part of the way, with an occasional long meadow filled with coarse wild grass. On our ride frequent belts of middling sized poplar were passed, and as we approached lake Mille Lacs, we met with more timber, oak, maple, birch, butternut, "butternut hickory" and soft pine, tamarac and spruce with some Norway and Jack pine. The distance from Brainerd to the lake is about 25 miles, and the road, which near the town is comparitively good, as it approaches the lake becomes rough, stony, and somewhat hilly.

Lake Mille Lacs, on account of its large size and the sameness of its shores, is not as attractive, I think, as many smaller lakes seen in Otter Tail county. Along the northwest shore the water is very shallow and the beach is sandy, and on the southeast shore, at one place the depth, for a mile from shore, does not exceed three feet. In other places, however, as on the south shore and along the north shore, the land is high and the banks are very precipitous and rocky, and the water close to shore is deep. Along the northwest shore for a distance of two miles or more is a very regular ridge, about 20 yards above the level of the lake, which with the beach makes a very well formed terrace, although probably formed by glacial action.

Near the southeast shore of the lake, about a mile from the land, there is said to be a broad granite ledge perfectly flat on top, which, at low water is about three feet above the surface and at high water just below the surface. Another outcrop of this granite is seen in townships south and west of the lake. Three barren and rocky islands a short distance from the southeast shore, the largest one containing about three-fourths of an acre, and known as Stone island (called Spirit island by the Indians) form breeding places for countless gulls.

In conversation with Mr. Johnson, an old salt-water sailor, who has lived on the lake for nine years, I learned that the Indians have never seen the lake so low as it is now.

Johnson is of the opinion, too, that Rum river has not always been the outlet from the lake, but that years ago the water found an exit by way of Knife river, some miles east of Rum river. Although the Knife is now but a small brook, he says that the

broad meadow overgrown with tamarac which extends many miles on both sides of the stream, shows indications of at one time being the bed of a large stream; and also says that on the high banks, at the edge of the meadow, he has found smooth, waterworn boulders.

His theory is that at some former time, when the water in the lake was much higher than it is now, not only did a stream run down the Knife river bed, but the water must have broken over the high banks then existing on the shore of the lake at Rum river and cut its way down through, eating out the channel which is now Rum river and cutting it down so low that its bed was below the bed of Knife river, so that now, the lake being much lower than formerly, the Rum river channel receives what water flows out.

Quoting from my diary of Nov. 8, I here write down the substance of a conversation held with Mr. O. E. Garrison, at lake Mille Lacs:

"South of lake Mille Lacs, at the very edge of the lake, and running southwest from Lake Superior to the southwestern part of Minnesota and beyond, is a line of granite which, theory says, is made by upheaval. In places it is covered with a layer of sandstone of the nature of drift. Again, in T. 24, R. 43, according to Garrison's map, near the center of the square, is a mass of granite, somewhat elevated, with a fissure on the northern side. In this region, two summers ago, about July 15th, Garrison was surveying with a friend and they found in that fissure, even at that date, a large amount of solid ice."

Mr. Garrison lives upon an old battle-field of the ancient mound-builders. Just back of his house are three mounds which would indicate that hostile tribes had a fight there at one time, and that the dead were interred on the spot. Running southwest from the mounds is an almost obliterated ridge averaging three feet in height. This ridge, he thinks, was at one time an old fortification of the mound-builders.

The largest of these three mounds is forty feet in diameter and from ten to fifteen feet high. This was opened a year ago and numerous skeletons found sitting upright, and so old that the thin pieces of bone crumbled away as soon as touched. In the same mound were found stone implements and weapons, and some pottery.

XI.

CHEMISTRY.

REPORT OF PROF. JAS. A. DODGE.

MINNEAPOLIS, MINN., May 27, 1886.

Prof. N. H. Winchell:

DEAR SIR:—I hereby report to you the results of certain analyses made at this laboratory, for the State Geological Survey, since my last report.

Chem. Series No. 174. A mineral from lake Superior, No. 575, of the geological survey series.

Silica, SiO_2	45.47	per cent.
Alumina, Al_2O_3	21.01	"
Peroxide of iron, Fe_2O_3	3.60	"
Lime, CaO, combined with silica	18.87	"
Lime, CaO, combined with carbonic acid	5.22	"
Carbonic acid, CO_2	4.10	"
Magnesia, MgO	.16	"
Potash, K_2O	.21	"
Soda, Na_2O	.93	"
Water, H_2O	.83	"
	100.40	

This mineral appears to be a kind of zoisite.

Chem. Series No. 175. Water from the deep well at Brown's Valley.

	Parts per Million.	Grains per U. S. Gallon.
Silica, SiO_2	13.00	.7583
Alumina, Al_2O_3	.40	.0233
Protoxide of iron, FeO	.70	.0408
Calcium sulphate, $CaSO_4$	51.80	3.0215
Magnesium sulphate, $MgSO_4$	27.90	1.6270
Sodium sulphate, Na_2SO_4	1452.60	84.7302
Calcium phosphate, $Ca_3(PO_4)_2$	5.00	.2916
Sodium chloride, NaCl	912.70	53.2378
Potassium chloride, KCl	traces.	
Carbonic acid, Co_2	traces.	
Nitrates	traces.	
Total mineral matter	2464.10	143.7305

Test for organic matter, with permanganate of potash, amount of oxygen consumed, 1.63 parts per million.

This water is remarkable for the large amount of sulphates.

Chem. Series No. 176. This number was a sample of cupriferous rock. It was assayed by myself, for gold, silver and copper. The results of the assay were as follows:

Gold	$\frac{1}{10}$ Troy ounce per ton.
Silver	$\frac{2}{10}$ " " "
Copper	$\frac{17}{100}$ of one per cent.

Chem. Series No. 177. This was also a sample of cupriferous rock. It was assayed with the following results:

Gold	$\frac{2}{100}$ Troy ounce per ton.
Silver	$\frac{1}{10}$ " " "
Copper	$\frac{11}{100}$ of one per cent.

Chem. Series No. 178. Kaolin brought by Col. J. B. Clough in February, 1886.

Silica, SiO_2	49.66	per cent.
Alumina, Al_2O_3	37.29	"
Peroxide of iron, Fe_2O_3	.76	"
Lime, CaO	.61	"
Magnesia, MgO	.02	"
Potash, K_2O	1.23	"
Soda, Na_2O	.71	"
Water, H_2O	9.72	"
Carbonic acid, Co_2		traces.
Organic matter		traces.
	100.00	

The analysis shows that this is a kaolin of good quality. It is comparatively free from oxide of iron and lime. The small amounts of oxide of iron, lime, magnesia, potash and soda would not, in my opinion, interfere with its use for the usual purposes to which kaolin is applied. The water reported in the analysis belongs to the chemical composition of the substance and would only be expelled by burning. The mineral was analyzed after drying at a temperature not exceeding 100 degrees centigrade.

Very respectfully yours,

JAMES A. DODGE,

Professor of Chemistry.

XII.

ORNITHOLOGY.

REPORT OF DR. P. L. HATCH.

Prof. N. H. Winchell:

DEAR SIR:—I have the honor to report that while relaxing no measures hitherto employed in the acquisition of all information possible relating to the avi-faunæ of the state, I am pursuing the preparation of a report as fast as the onerous demands of my other duties will permit.

By personal observations, and a somewhat extended correspondence with gentlemen competent to communicate reliable information in different parts of the state, together with the invaluable aid of Mr. F. L. Washburn, who spent some time in field-work last fall in the Red River Valley, I am able to report progress in still accumulating valuable facts to be embodied in the report, which but for reasons known to you, and a prolonged detention by sickness, would have ere this been closed. The labor has been much greater than my experience had anticipated, especially in consideration of the impossibility of consecutive engagement in it. I hope now before a great while to finish the land birds, and enter upon the water birds, which will be very much less voluminous.

Very respectfully yours,

P. L. HATCH.

1015 Mary Place, June 1st, 1886.

APPENDIX.

NOTES ON SOME DEEP WELLS IN MINNESOTA.

(*Continued from page* 16.)

The deep well at Albert Lea. The drillings from this well, which is 300 feet deep, were furnished by mayor A. C. Wedge. The well was made by Mr. Swanson in the summer of 1885. This well is situated in the high level near the business portion of the city, and the water stands at 22 feet below the surface. About 60 rods from this well Mr. William Morin sank another, beginning at a lower level, in the bed of what was once Spring lake, and penetrated to the depth of 204 feet. Flowing water in this well was obtained at 120 feet, but the well was continued deeper with a hope of getting a stronger flow. The discharge is about 400 barrels per day, of good quality and a temperature of 50 degrees, Fah. The drillings of this well have not been examined, but it is the opinion of mayor Wedge that the strata struck proved to be about the same as those given below as far as the drill penetrated. The water is apparently of the same quality. The iron films from the depth of 165 feet were derived from a bucket which became fast in the well and was drilled out.

1.	Mus. Reg. No. 6191.	Drift gravel largely limestone, from the depth of	80 feet.
2.	" " " 6192.	Drift sand and gravel, from	95 feet.
3.	" " " 6193.	Drift sand, mainly quartz, from	105 feet.
4.	" " " 6194.	Drift gravel and sand, from	112 feet.
5.	" " " 6195.	Drift sand, from	113 feet.
6.	" " " 6196.	Drift sand, with magnesian limestone, from	114 feet.
7.	" " " 6197 and 6198,	Magnesian limestone and sand, from	115 feet.
8.	" " " 6199.	Drift sand, with some limestone, from	130 feet.
9.	" " " 6200.	Magnesian limestone, with a few grains of drift sand, from	143 feet.
10.	" " " 6201.	Light-gray shale, slightly effervescing,	155 feet.
11.	" " " 6202.	" " " "	160 feet.
12.	" " " 6203.	Battered films of metallic iron, somewhat rusted, from	165 feet.
13.	" " " 6204.	Gray shale, sandy, effervescing, with some films of iron, from	172 feet.
14.	" " " 6205.	Gray shale, from	210 feet.
15.	" " " 6206.	Gray shale, from	213 feet.
16.	" " " 6207.	Calcareous shale, nearly white, from	220 feet.
17.	" " " 6208.	Compact, light-colored limestone, mixed with some drift-sand from above, or some arenaceous stratum, from	230 feet.

18. Mus. Reg. No. 6209. Drillings have a mixed composition; though mainly of magnesian limestone, yet of different grain and color; also containing considerable sand, and some chert and fine crystals of silica referable to geodes in the rock; one large fragment is distinctly arenaceous, from .... 234 feet.
19. Mus. Reg. No. 6210. Mainly white quartz sand, rounded and also angular; the rest is magnesian limestone, readily effervescing; both are in fine grains and fragments, from .... 236 feet.
20. Mus. Reg. No. 6211. Same as the last, from .... 237 feet.
21. " " " 6212. Same as the last, from .... 240 feet.
22. " " " 6213. Mainly a homogeneous, buff, magnesian limestone, with some quartz sand, from .... 241 feet.
23. Mus. Reg. No. 6214. The drillings consist, mainly of the same, light-buff magnesian limestone, but contain also numerous pieces of a dark earthy shale, not inflammable nor combustible, from .... 243 feet.
24. Mus. Reg. No. 6215. Reddish-buff magnesian limestone, with some fragments of opaque white silica and some rounded sand, from .... 248 feet.
25. Mus. Reg. No. 6216. Same as the last, from .... 250 feet.
26. " " " 6217. The same without silica and sand, from .... 254 feet.
27. " " " 6218. Reddish-buff, compact, magnesian limestone, from .... 258 feet.
28. " " " 6219. The same, from .... 260 feet.
29. " " " 6220. Reddish-buff, compact, magnesian limestone, mottled with gray, from .... 265 feet.
30. Mus. Reg. No. 6221. The same, without gray mottlings, but with some chert and some sand, from .... 270 feet.
31. Mus. Reg. No. 6222. Light-gray to buff, crystalline magnesian limestone, with rare beads from crinoid filaments, from .... 275 feet.
32. Mus. Reg. No. 6223 Buff magnesian limestone, from .... 285 feet.
33. " " " 6224. Light-buff magnesian limestone, some of the drillings being unwashed, and then, dried, resembling a light gray shale, from .... 295 feet.
34. Mus. Reg. No. 6225. Vesicular, buff, magnesian limestone, resembling the upper part of the Niagara limestone, from .... 300 feet.

There is but little to serve as a guide in assigning these limestone strata to their geological horizon. There is, in the Albert Lea well, a thickness of about 186 feet of limestone which does not vary very much lithologically, extending from 114 feet to 300 feet. It is shaly in some places, and also arenaceous. These characters would not preclude the Galena limestone, which is thought to be the most probable rock in that geographical area. If, however, the Devonian limestones extend as far north as Albert Lea, these beds could all be assigned to that age, as far as their lithology is concerned, except Nos. 33 and 34 which have a greater resemblance to the Niagara. This would bring the Devonian upon the upper Silurian, as supposed in the deep well at Austin. The shale extending from 155 to 220 feet, a thickness of 65 feet, would, in that case, represent the Austin rock, and the mixed and arenaceous beds extending from 220 feet to 240 feet would parallelize with the conglomerate of the Austin well. There would be then 45 feet of magnesian limestone in the Albert Lea well, below the

conglomerate horizon, before the lithology of the Niagara is recognizable. This would fall into the upper part of No. 8 of the Austin well.

Joseph Goar's well, near Morristown, Rice County. This peculiar well was noted in the final report on Rice county. (vol. i, p. 671.) It is in N. E. ¼ sec. 33, Morristown. In a recent communication Mr. Goar gives more particulars concerning the action of this well.

It was dug fourteen years ago, to the depth of seventy feet. At about twenty feet, sand was struck with occasional beds of gravel, largely consisting of limestone. At fifty feet a sound resembling escaping steam was heard. The well being curbed as fast as dug little more was heard or noticed of this. Water to the depth of sixteen or eighteen inches was secured. The well was open, water being drawn by a bucket. In winter the bucket would freeze fast, and finally the whole surface was permanently frozen solid till warm weather came again. Then it was found that when the wind was strong from the north, or a little east or west of north, water could not be got, but a few hours wind from the south or southeast would insure plenty of water. At first it would look as if it had been agitated by wind, but soon became clear. Small black frogs, "with feet like chickens, no web between the toes," were sometimes drawn up, were said to have been drawn up often. These were so small they would get inside the links of an old fashioned trace chain.

More lately the well has been sunk about five feet deeper, an iron pump and pipe put into it, and filled up about seventeen feet with gravel and the opening at the top covered. It is now found that a strong current of air passes sometimes in and sometimes out of the top. The water is clear and softer than the common well-water of the country round. By keeping the well closely covered there is but little trouble from freezing. When it blows out it thaws everything about the top. The force of air going in or out, if confined to a small vent, has been heard at a distance of a hundred yards.

This can only be explained by supposing some connection with the surface through gorges in the rock, or through some gravel bed. The condition of the surface of the country, in Morristown,

prior to the drift epoch, may have been somewhat like that in Winona and Houston counties, and after the deposition of the drift some subterranean passages were still unfilled.

The Tracy deep well. This well was drilled by Messrs. Swan and Stacey, in the winter of 1885-86. Its depth is 724 feet four inches, and penetrates the granite about thirty-one feet. Water was found at about one hundred and fifty feet, which rose to within about thirty-seven feet of the surface. It did not apparently change in respect of hydrostatic pressure after it was first struck.

Through the courtesy of Hon. W. O. Musser, president of the village council, and the co-operation of Messrs. Swan and Stacey, the subjoined record of the depths of the different strata of this well has been obtained. This record was accompanied by a set of drillings, and from these the writer has made out the descriptive notes. The corresponding numbers of the museum register are 6492 to 6516.

No. of Sample.	No. of feet deep.	Total No. of feet.	DESCRIPTION.
1	1	1	Black loam soil.
2	19	20	Yellowish, pebbly clay.
3	100	120	Blue till.
4	5	125	Fine gravel, largely of limestone, having a nearly black general aspect, owing to fine disseminated organic matter. This contains some fine sand, and some soil-like matter. It also contains a few fragments of slag or furnace-clinker, of vegetable fiber, Cretaceous lignite, small pieces of pyrite apparently from the Cretaceous, and fibers of metallic iron evidently from the drill
5	20	145	Fine blue clay, Cretaceous?
6	20	165	Coarse gravel, embracing numerous pieces of buff limestone, and of crystalline rock, also of grey and dark or reddish quartzyte, pieces ranging from an inch in diameter to a thirty-second part of an inch, or finer. The whole being dirty and looking as if gathered on the surface of the ground in the soil and unwashed. There are in this lot several pieces of grey, gritty quartzyte evidently from the Cretaceous, and of grey conglomerate or coarse sandstone, and of concretionary iron pyrites. But the most singular portion is the slag similar to that mentioned in No. 4. This shows all stages of solidification from loose light pumice to black obsidian, and to black sub-crystalline hard rock. It is in fragments as large as three-fourths of an inch in longest diameter, and in pellets round as shot, no larger than the eye of a needle. It is nearly all black, and is often amygdaloidal, some of it being magnetic. Embraced in this lot are also beds of lignite and of concretionary pyrites. On one of the angular black masses of stone, evidently broken from the formation, are very evident remains of woody fiber, now in the form of charcoal. Fibers of metallic iron are equally common in this as in No. 4.
7	12	177	Fine blue clay, evidently Cretaceous.
8	20	197	Fine sandstone, homogeneous, light greenish-blue, Cretaceous.
9	213	410	Dark gray shale, Cretaceous, occasionally containing a rounded small pebble of buff limestone.
10	60	470	Fine light-blue or greenish sand.
11	43	513	Blue clay or shale, not fissile but rather massive, with fine kaolinic and micaceous particles.
12	32	545	Cretaceous grit, consisting of angular and sub-angular grains of white quartz, also embracing numerous pieces of concretionary iron pyrites.
13	5	550	Fine grey sandstone.
14	30	580	Blue clay, like that of No. 11.
15	7	587	Angular and rounded grains of sand, mainly white quartz, but also containing pieces of pyrite, and films of iron from the drill.
16	24	611	Dark, unctuous, fine clay.
17	8	619	White, kaolinic clay, becoming reddish, then bluish and gritty; mingled in the lot with sub-angular grains of quartz.
18	8	627	White and grey quartz sand, the latter in concretionary lumps, cemented by pyrite.
19	10	637	The same as the last, but containing kaolinic material.
20	25	662	White kaolin, clouded with blue clay, and containing some grit.
21	2	664	White angular quartz sand, grains opaque, containing dull, olive colored siliceous lumps apparently made up of a great number of small grains cemented; also some kaolin, some shale, and some pyrite.
22	2	666	The same as the last.
23	6	672	The same as the last, but finer, more rounded and more homogeneous.
24	18	690	White sand, mainly angular, fine and homogeneous, but containing some coarse grains of angular quartz and some kaolinic material, the latter apparently resulting from the decay of grains of feldspar after deposition in the sandstone.
25	2	715	Reddish orthoclastic granite becoming chloritic.

The most interesting thing about this record is found in Nos. 4, 5 and 6. Here we find, separating the drift from the more evident cretaceous beds, a remnant of the old soil which accumulated on the Cretaceous rocks during the Tertiary age. There are two gravelly deposits separated by a fine blue clay. This clay may be a representative of the Tertiary. The lower gravelly bed, containing much slag and coarse gravel, can be supposed to have accumulated on the Cretaceous after the withdrawal of the Cretaceous ocean; the slag coming from the combustion of the lignites contained in the strata, in the same manner as seen at the present time in Dakota and Montana, producing many of the phenomena of volcanoes. After a submergence, and the accumulation of twenty feet of (Tertiary?) blue clay, another soil accumulated over the blue clay similar in all characters to the former. On this, afterward, was brought the glacial till by the operations of the post-Tertiary age. This history is indicated by the presence of these igneous particles in the drillings from this depth, and it is no more than might be expected from the abundant ashes and charcoal that accompany the Cretaceous lignites in their exposures at and near Redwood Falls. These particles of slag, however, may have been adventitiously introduced in the drillings from some coal-stove or other fire-box; and this is strengthened by the fact that in No. 4 is also found a fragment of an eight penny nail of iron.

The deep well at Gibbon, on the Minneapolis and St. Louis railway. Sec. 2, T. 112, R. 31, Sibley Co.

This was drilled by the Minneapolis and St. Louis railway, and Mr. W. B. Hixson has supplied the following facts:

1.	Blue clay, dry, with small gravel-stones and an occasional boulder	275 feet.
2.	Sand, with water which rose forty or fifty feet above the sand; also containing remains of wood, having the appearance of modern drift-wood (6245 and 6246)	20 feet.
3.	Red granite (6247)	30 feet.

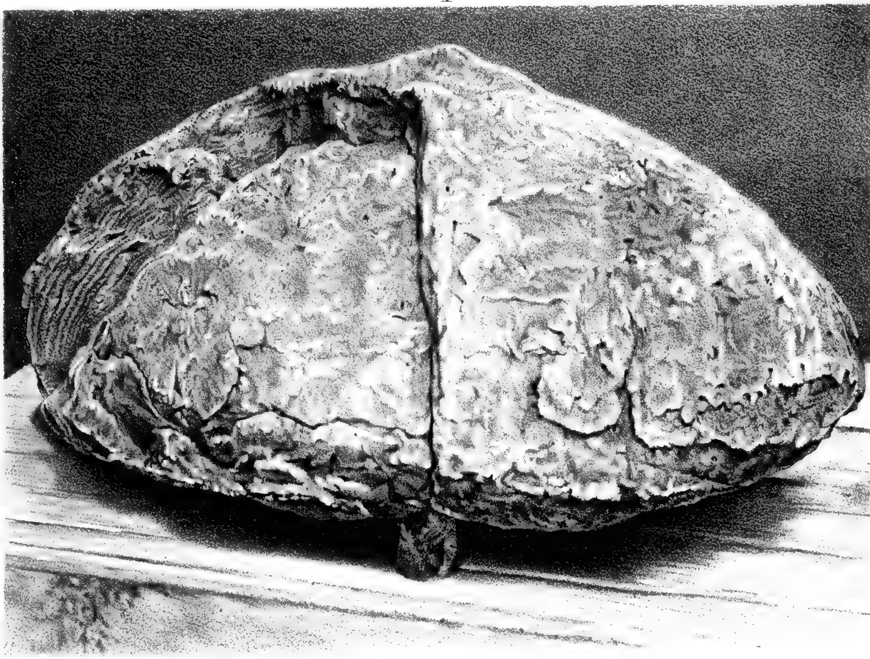
EXPLANATION OF PLATE I.

PAGE.

Cryptozoon minnesotense, n. sp........................... 313

1. View of the exterior of a large specimen showing a section of the Laminæ where a segment of the surface has been removed; also the undulating or knobbed upper surface of the laminæ. From a photograph, reduced from the natural size to about one-fourth.
2. View of the same specimen showing the base, reduced to one-fourth the natural size, from a photograph. This specimen, as represented, is coated on the bottom with a layer of calcareous tufa, which renders the concentric ridges much less evident and continuous.

1



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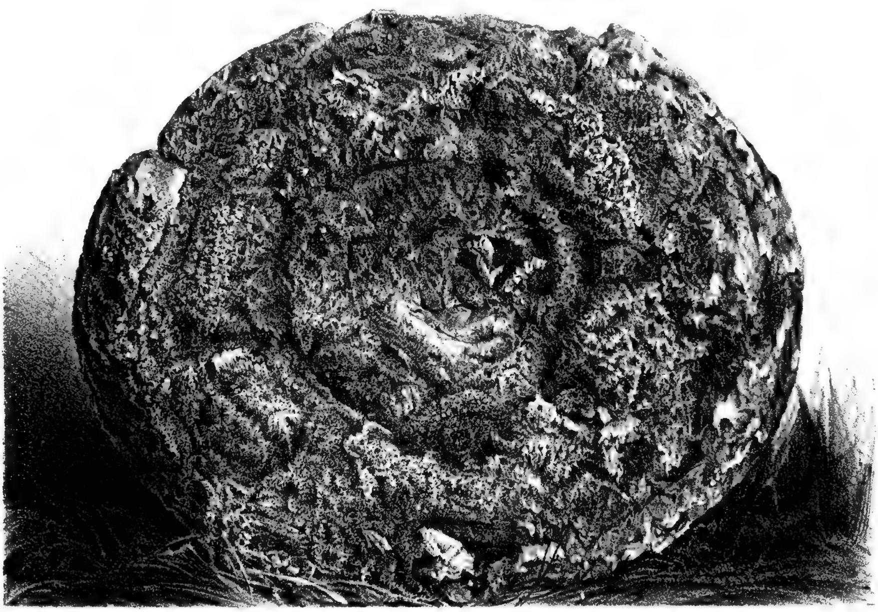


EXPLANATION OF PLATE II.

PAGE.

Cryptozoon minnesotense, n. sp. 313

3. View of a thin section, perpendicular to the laminæ; natural size.

PAGE.

Cryptozoon minnesotense, var *libertatis*, n. var. 314

4. External appearance of an ordinary specimen; natural size. The upper end is nearly entire; the lower end shows a section across the concave base.

PAGE.

Rhynchonella ainsliei, n. sp. 315

5. Front view of a mature specimen; natural size.
6. Profile view of a mature specimen; natural size.

PAGE.

Orthis remnicha, n. sp. 317

7. External view of the larger valve; natural size.

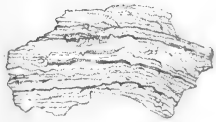
PAGE.

Orthis sandbergi, n. sp. 318

8. Cast of the exterior of the larger valve; natural size.
9. Cast of the interior of the larger valve; natural size.

4

3



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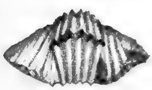

6

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PUBLICATIONS OF THE GEOLOGICAL AND NATURAL HISTORY SURVEY OF MINNESOTA.

I. ANNUAL REPORTS.

THE FIRST ANNUAL REPORT ON THE GEOLOGICAL AND NATURAL HISTORY SURVEY OF MINNESOTA, FOR THE YEAR 1872. 112 pp., 8 vo.; with a colored map of the State. By *N. H. Winchell*. Published in the Regents' Report for 1872. Out of print.

THE SECOND ANNUAL REPORT ON THE GEOLOGICAL AND NATURAL HISTORY SURVEY OF MINNESOTA, FOR THE YEAR 1873. 145 pp., 8 vo.; with illustrations. By *N. H. Winchell* and *S. F. Peckham*. Published in the Regents' Report for 1873. Out of print.

THE THIRD ANNUAL REPORT ON THE GEOLOGICAL AND NATURAL HISTORY SURVEY OF MINNESOTA, FOR THE YEAR 1874. 42 pp., 8 vo ; with two county maps. By *N. H. Winchell*. Published in the Regents' Report for 1874. Out of print.

THE FOURTH ANNUAL REPORT ON THE GEOLOGICAL AND NATURAL HISTORY SURVEY OF MINNESOTA, FOR THE YEAR 1875. 162 pp., 8 vo ; with four county maps and a number of other illustrations. By *N. H. Winchell*, assisted by *M. W. Harrington*. Also in the Regents' Report for 1875. Out of print.

THE FIFTH ANNUAL REPORT ON THE GEOLOGICAL AND NATURAL HISTORY SURVEY OF MINNESOTA, FOR THE YEAR 1876. 248 pp., 8 vo.; four colored maps and several other illustrations. By *N. H. Winchell*, with reports on Chemistry by *S. F. Peckham*, Ornithology by *P. L. Hatch* Entomology by *Allen Whitman*, and on Fungi by *A. E. Johnson*. Also in the Regents' Report for 1876. Out of print.

THE SIXTH ANNUAL REPORT ON THE GEOLOGICAL AND NATURAL HISTORY SURVEY OF MINNESOTA, FOR THE YEAR 1877. 226 pp., 8 vo.; three geological maps and several other illustrations. By *N. H. Winchell*, with reports on Chemical Analyses by *S. F. Peckham*, on Ornithology by *P. L. Hatch*, on Entomology by *Allen Whitman*, and on Geology of Rice county by *L. B. Sperry*. Also in the Regents' Report for 1877. Out of print.

THE SEVENTH ANNUAL REPORT ON THE GEOLOGICAL AND NATURAL HISTORY SURVEY OF MINNESOTA, FOR THE YEAR 1878. 123 pp., 8 vo.; with twenty-one plates. By *N. H. Winchell*, with a Field Report by *C. W. Hall*, Chemical Analyses by *S. F. Peckham*, Ornithology by *P. L. Hatch*, a list of the Plants of the north shore of Lake Superior by *B. Juni*, and an Appendix by *C. L. Herrick* on the Microscopic Entomostraca of Minnesota (twenty-one plates). Also in the Regents' Report for 1878.

THE EIGHTH ANNUAL REPORT ON THE GEOLOGICAL AND NATURAL HISTORY SURVEY OF MINNESOTA, FOR THE YEAR 1879. 183 pp., 8 vo.; one plate (Castoroides). By *N. H. Winchell*. Containing a statement of the methods of Microscopic Lithology, a discussion of the Cupriferous Series in Minnesota, and descriptions of new species of brachiopoda from the Trenton and Hudson River formations; with reports on the Geology of Central and Western Minnesota, by *Warren Upham;* on the Lake Superior region, by *C. W. Hall;* lists of Birds and of Plants from Lake Superior, by *Thomas S. Roberts;* Chemical Analyses by *S. F. Peckham;* report by *P. L. Hatch;* and four Appendixes. Also in the Regents' Report for 1879 and 1880. Out of print.

THE NINTH ANNUAL REPORT ON THE GEOLOGICAL AND NATURAL HISTORY SURVEY OF MINNESOTA, FOR THE YEAR 1880. 392 pp., 8 vo.; three appendixes, two wood cut illustrations, and six plates. By *N. H. Winchell.* Containing field descriptions of 442 crystalline rock samples, and notes on their geological relations, from the northern part of the state; new brachiopoda; the water supply of the Red River Valley, and simple tests of the qualities of water; with reports on the Upper Mississippi region, by *O. E. Garrison;* on the Hydrology of Minnesota, by *C. M. Terry;* on the Glacial Drift and its Terminal Moraines, by *Warren Upham;* Chemical Analyses by *J. A. Dodge;* a list of the Birds of Minnesota, by *P. L. Hatch;* and of the Winter Birds, by *Thomas S. Roberts.* Also in the Regents' Report for 1879 and 1880.

THE TENTH ANNUAL REPORT ON THE GEOLOGICAL AND NATURAL HISTORY SURVEY OF MINNESOTA, FOR THE YEAR 1881. 254 pp., 8 vo.; with ten wood cut illustrations, and fifteen plates. By *N. H. Winchell.* Containing field descriptions of about 400 rock samples, and notes on their geological relations, continued from the last report; the Potsdam sandstone; typical thin sections of the rocks of the Cupriferous Series; and the deep well at the "C" Washburn mill, Minneapolis; with Geological notes, by *J. H. Kloos;* Chemical Analyses by *J. A. Dodge;* and papers on the Crustacea of the fresh waters of Minnesota (eleven plates), by *C. L. Herrick.* Also in the Regents' Report for 1881 and 1882.

THE ELEVENTH ANNUAL REPORT ON THE GEOLOGICAL AND NATURAL HISTORY SURVEY OF MINNESOTA, FOR THE YEAR 1882. 219 pp., 8 vo.; with three wood cut illustrations and one plate. By *N. H. Winchell.* Containing a report on the Mineralogy of Minnesota, and a note on the Age of the rocks of the Mesabi and Vermilion iron districts; with papers on the Crystalline rocks of Minnesota, by *A Streng* and *J H. Kloos;* on Rock outcrops in central Minnesota, and on Lake Agassiz, by *Warren Upham;* on the Iron region of Northern Minnesota, by *Albert H. Chester;* Chemical Analyses by *J. A. Dodge;* and an Appendix containing Minnesota Laws relating to Mines and Mining, abstracted by *C. L. Herrick.* Also in the Regents' Report for 1881 and 1882.

THE TWELFTH ANNUAL REPORT ON THE GEOLOGICAL AND NATURAL HISTORY SURVEY OF MINNESOTA, FOR THE YEAR 1883. Summary report, containing palæontological notes, and a paper on the comparative strength of Minnesota and New England granites, 26 pages, by *N. H. Winchell*; final report on the Crustacea of Minnesota included in the orders Cladocera and Copepoda. 192 pages and 30 plates, by *C. L Herrick*, and a catalogue of the flora of Minnesota, 193 pages, with one map showing the forest distribution, by *Warren Upham.* Also in the Regents' Report for 1883-84.

THE THIRTEENTH ANNUAL REPORT ON THE GEOLOGICAL AND NATURAL HISTORY SURVEY OF MINNESOTA FOR THE YEAR 1884. 196 pages. Geological reconnoisances, the Vermilion iron ores, the crystalline rocks of Minnesota, and of the Northwest, the Humbolt salt well in Kittson county, records of various deep wells in the state, fossils from the red quartzyte at Pipestone, reports on the New Orleans Exposition and on the General Museum, by *N. H. Winchell;* Geology of Minnehaha county, Dakota, by *Warren Upham;* Chemical report by *Prof. Jas. A. Dodge;* Minnesota geographical names derived from the Dakota language by *Prof. A. W. Williamson;* insects injurious to the cabbage, by *O. W. Oestlund;* Geological notes in Blue Earth county, by *Prof. A. F. Bechdolt*, and on a fossil elephant from Stockton by *Prof John Holzinger;* papers on the Cretaceous fossils in the boulder clays in the Northwest by *George M. Dawson* and by *Woodward* and *Thomas*, and notes on the Mammals of Big Stone Lake and vicinity by *C. L. Herrick.*

II. FINAL REPORT.

THE GEOLOGY OF MINNESOTA. VOL. I. OF THE FINAL REPORT. 1884; xiv and 697 pp., quarto; illustrated by 43 plates and 52 figures. By *N. H. Winchell*, assisted by *Warren Upham.* Containing an Historical sketch of Explorations and Surveys in Minnesota, the general Physical features of the state, the Building stones, and the Geology of Houston, Winona, Fillmore, Mower, Freeborn, Pipestone, Rock and Rice counties, by *N. H.*

Winchell; the Geology of Olmsted, Dodge and Steele counties, by *M. W. Harrington;* and the Geology of Waseca, Blue Earth, Faribault, Watonwan, Martin, Cottonwood, Jackson, Murray, Nobles, Brown, Redwood, Yellow Medicine, Lyon, Lincoln, Big Stone, Lac qui Parle and Le Sueur counties, by *Warren Upham.* Distributed gratuitously to all public libraries and county auditors' offices in the state, to other state libraries and state universities, and to leading geologists and scientific societies; the remainder are held for sale at the cost of publication, $3.50 per copy in cloth, or $5 in grained half roan binding, upon application to Prof N. H. Winchell, Minneapolis.

III. MISCELLANEOUS PUBLICATIONS.

1. CIRCULAR No. 1. A copy of the law ordering the survey, and a note asking the co-operation of citizens and others. 1872.
2. PEAT FOR DOMESTIC FUEL. 1874. Edited by *S. F. Peckham.*
3. REPORT ON THE SALT SPRING LANDS DUE THE STATE OF MINNESOTA. A history of all official transactions relating to them, and a statement of their amount and location. 1874. By *N. H. Winchell.*
4. A CATALOGUE OF THE PLANTS OF MINNESOTA; prepared in 1865 by *Dr. I. A. Lapham,* contributed to the Geological and Natural History Survey of Minnesota, and published by the State Horticultural Society in 1875.
5. CIRCULAR No. 2. Relating to botany, and giving general directions for collecting information on the flora of the state. 1876.
6. CIRCULAR No. 3. The establishment and organization of the Museum. 1877.
7. CIRCULAR No. 4. Relating to duplicates in the Museum and exchanges. 1878.
8. THE BUILDING STONES, CLAYS, LIMES, CEMENTS, ROOFING, FLAGGING AND PAVING STONES OF MINNESOTA. A special report by *N. H. Winchell.* 1880.
9. CIRCULAR No. 5. To Builders and Quarrymen. Relating to the collection of two-inch cubes of building stones for physical tests of strength, and for chemical examination, and samples of clay and brick for the General Museum. 1880.
10. CIRCULAR No. 6. To owners of mills and unimproved water-powers. Relating to the Hydrology and water-powers of Minnesota. 1880.

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